London School of Hygiene & Tropical Medicine

DFID PROGRAMME

ON MALARIA

TRIENNIAL REVIEW 1995/98

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MALARIA RESEARCH WORK PROGRAMME

Summary

The third programme year has been characterised by important outputs from the Indian trial of insecticide-treated mosquito nets (ITMN), completion of Tanzanian downstream work on ITMN leading into operational projects and a global review of progress in this area, decisive progress in the work on urban malaria in Surat, conclusion of trials of one vaccine and progress with more hopeful ones as well as with new chemotherapeutic agents. The El Niño climatic cycle has been shown to have a high predictive value for malaria while the highland malaria work has developed into a substantial multicentre study. Important developments have taken place in vaccines and chemotherapy. Research findings have substantially affected policy and practice in several countries. As several complex research and capacity building areas are now producing results and affecting policy, narratives of some of these studies are appended in fuller form in annex 5 in relatively non-technical language. In eastern Africa a new and unpredicted method of malaria protection for poor households has been developed. Capacity building in Asia and Africa, and of newer UK staff, is being fruitful.

1 Research Outputs

1.1, 1.2 Major Research Themes, and their Policy Significance

MALARIA PREVENTION AND MANAGEMENT

Insecticide-Treated Bed Nets (ITMN)

The Programme has contributed to technical evaluation, technological development, and the development of implementation strategies.

A major efficacy trial in rural India, was needed because many indigenous malariologists are sceptical of the value of ITMN and no previous very large community randomized trial of ITMN against malaria transmitted by *An. culicifacies,* the main vector in rural India, had been done. The first year results show that ITMN prevent malaria more effectively than household spraying, reducing malaria incidence by 52.6% and 28.4% respectively. A senior staff member of NMEP carried out the field work as a doctoral project, strengthening research capacity of NMEP and facilitating incorporation of results into national policy. ITMN may receive massive investment through NMEP, which is also interested in the cost-effectiveness comparison (developed with the DFID Health Economics Programme) with housespraying, which currently consumes the great majority of the national malaria control budget.

The Work Programme has pioneered the development of the "dip-it-yourself" approach to insecticide distribution, with support from HP-ACCORD and WHO-TDR. Using a combination of technical and social-scientific assessments, it has been shown that home-treatment kits can be used safely and effectively even in semi-literate communities. Three years ago there was considerable scepticism about this idea, now there is considerable demand for such kits from projects, and at least three major manufacturers are developing products and formulations aimed at this market. The commercial viability of such kits is being tested in two large social marketing projects in Tanzania, one funded by DFID-East Africa and designed by Programme staff.

A critical operational need in insecticide distribution is a simple and cheap method of quality control. An ELISA test to quantify pyrethroid deposits on fabric is being developed.

The Programme has also begun work on a promising substitute for mosquito coils. The market for domestic insecticides is very large (we have estimated US$1 million per month in Dar es Salaam alone), and much of this money is spent on coils (especially by poor people). Lamps made by local tinkers and adapted to heat volatile pyrethroids are more effective than coils and promise to be cheaper (about 2US cents per night). A patent application is being prepared.

The Programme has had considerable influence on the design of implementation projects and national programmes, through consultancies (in India, Tanzania and Rwanda), through meetings and workshops (with USAID and WHO-AFRO), through PhD research (in Mozambique) and through publications (the Net Gain book, amongst others). A field survey of the lessons of experience from over 20 net projects all over the world has been completed, and a Handbook for Project Managers has been drafted and is now being edited in collaboration with the Malaria Consortium. A scheme to guide national programmes to combine public and private sector efforts with equity and sustainability is being planned.

Vaccination

A second-year follow-up of children in the Gambian SPf66 trial was undertaken in case a vaccine effect was delayed. No significant protection against clinical attacks of malaria was seen. Serological studies showed that nearly all children responded to vaccination with high antibody titres to SPf66 so that an inability of Gambian infants to respond immunologically to SPf66 was not the reason for its lack of a protective effect. Detailed molecular biological studies on their malaria parasites showed that fewer genotypes were present among parasites from vaccinated than from control children suggesting a reduced incidence of new infections.

The same Gambian site has been chosen for studies with a new sporozoite vaccine, RTS,S, developed by SKB/WRAIR which has given about 50% protection against infection in trials undertaken in American volunteers. A trial involving 300 Gambian adults is now in progress and we are developing methods to determine whether this vaccine will be as effective at preventing infection with wild parasites as in volunteers.

At the time that the Gambian SPf66 trial was started, enthusiasm for SPf66 was such that widespread immunisation with this vaccine was being contemplated in Africa. The results of the Gambian and another trial helped policy makers to decide not to use SPf66 for routine immunisation but to await the development of a more effective vaccine. Programme staff are monitors for two other vaccine trials.

Malaria Management

Many unsuccessful attempts have been made to design an algorithm for malaria diagnosis in the absence of microscopy. A new numerical scoring system only attempts to indicate the likelihood that a particular child has malaria on the basis of a numerical score. Application of this algorithm to febrile children in The Gambia showed that this increased the skill of field staff in malaria diagnosis to a level comparable to a well-trained paediatrician working without the support of microscopy. Such algorithms are likely to be site specific, so this approach is being tested in India. Over 3000 malaria clinic patients there have been recruited.

An ability to diagnose malaria on clinical grounds will become increasingly important as it becomes necessary to use for first line treatment drugs that are more expensive than chloroquine or Fansidar. Algorithms may help in more rational use of expensive drugs. Studies in Surat show substantial overtreatment of malaria cases.

Chemotherapy

The high level of resistance of *Plasmodium falciparum* to many antimalarial drugs in South East Asia and an increasing drug resistance problem in Africa indicate the urgent need for the development of new antimalarial drugs and of new ways in which existing drugs could be used.

CGP 56697, (coartemether), is a new antimalarial combining artemether with a novel, longer-acting antimalarial called benflumetol. Two trials of this antimalarial undertaken in The Gambia demonstrated that it was safe, effective, and also eliminated gametocytes. Good results have been obtained also during trials elsewhere and the drug is now being considered for registration.

In areas of high malaria transmission, it can be difficult to tell whether parasites which appear 14-28 days after treatment represent a treatment failure or a new infection. An attempt was made to do this during the course of the CGP 56697 trials using a new PCR method which allows comparison of the genetic characteristics of two or more parasite isolates. This new technique is likely to be used in many subsequent drug trials. Most apparent treatment failures were shown to be new infections.

The CGP trials, were the first studies of a new product undertaken in The Gambia to contribute to the process of registration and provided clinical and laboratory staff with training in the skills needed to undertake this rigorous kind of evaluation, skills that have subsequently proved of value in vaccine trials.

Chemoprophylaxis

The study showing a small rise in pregnancy malaria on iron supplements was completed.

In developing prophylactic advice for non-immune travellers, to malarious countries, long-term resident expatriates have received little attention so a collaborative study is in progress of antimalarial protection by 3000 UK residents (mostly CSO's, FO and DFID staff) staying in endemic areas for over a year, as a basis for better advice.

MALARIA UNDER CHANGING CONDITIONS

Work has increasingly focused upon urban malaria and on the effects of climatic change in relation to epidemic prediction and prevention.

Urbanization

Collaborative work with the Surat Medical College on 6 defined communities under epidemiological surveillance have combined studies of migration in relation to malaria, improved diagnosis, community and provider beliefs and behaviour, the public/private mix in service provision, entomological studies, and acceptability of ITMN. These combined will give a fuller picture of urban malaria than hitherto and are explained in Annex 5B. In addition to the specific findings, the multidisciplinary approach provides a methodology applicable elsewhere in India and which we hope to apply to African urban malaria, which has been little studied.

The public and private-for-profit providers of malaria services in urban Surat have been identified. Interviews have been held with the key stakeholder organizations to assess their perceptions and attitudes concerning malaria prevention and treatment, and their attitudes towards policy and the professional and regulatory context in which they work. Quality of care studies in progress will be followed by participatory methods to identify and pilot interventions to optimize the service

provided. Because private providers manage 90% of urban malaria, even of the poor, in India the policy relevance is apparent.

Migrant workers are being studied in three Surat slums to determine relations between migration patterns, origin, beliefs and behaviour, and malaria, to guide plans for their treatment and to focus environmental control of transmission.

Climate Change

The Programme has sought to answer four main questions: can irregular cyclic weather changes due to the El Nino phenomenon be used to predict malaria epidemics; are recent climate changes leading to changes in the altitudinal limits of malaria in Africa, and if so, can this be monitored and used to predict epidemics; can historical data sets be used to test models of the likely malaria consequences of environmental change? Our results affirm the first two and progress towards confirming the second two is occurring. We shall then develop the findings towards operational methods of epidemic prediction and preventive action.

In view of global climate change, and increasing instability of malaria in areas where malaria was previously controlled, identifying climate and environmental factors affecting transmission has become increasingly relevant. Historical malaria data offer retrospective opportunities to study environmental drivers of disease. In certain countries such as India and Venezuela, registration of mortality has been of sufficient quality over long enough for time series analysis from the period before mass intervention. Comparing past time series with present malaria data was shown to help strengthen associations and interpret present disease dynamics.

There has been particular recent concern over increasing levels of malaria transmission in highland areas, especially in Africa. We have been involved in co-organizing a major new multicentre project to assess the changing patterns of malaria transmission in African highlands and to evaluate environmental and anthropological risk factors for epidemics. This work is being carried out as part of the Mapping Malaria Risk in Africa (MARA) collaboration. In addition, a detailed study in the Ethiopian highlands is examining the importance of microclimatic variation on malaria transmission potential. Results indicate a much higher transmission potential than would be predicted from standard meteorological data.

In regions prone to periodic climate-related epidemics, long term climate prediction may assist in forecasting high and low risk years for malaria. Recently increasing ability to predict climate/weather 1-2 years in advance has enhanced the potential for early warning and improved preparedness for epidemics. Tailoring control strategies to the perceived risk should improve the cost effectiveness of control programmes: in the areas studied certain years have a 3-5 times increased epidemic risk, and tailoring control efforts could yield comparable benefits.

Widespread epidemics in highland areas of East Africa this year have demonstrated the need for new surveillance and early warning tools for planners. Products from the MARA highland malaria project will provide decision makers with reliable spatial estimates of epidemic risk.

Land and Water Development

West African studies with PEEM/WARDA on health effects of rice irrigation are developing from comparative disease impact studies towards a more intersectoral analysis. The key finding for malaria has been that the introduction of irrigation, though it may change the seasonal pattern of

clinical malaria, does not increase it or the EIR so that malaria hazard need not deter this type of development.

Surveillance

The thrust of our work has been particularly towards the use of GIS as an aid to medium scale surveillance of malaria, but the Programme has now developed several populations with very full monitoring of malaria which can be used in a re-examination of routine surveillance methods.

With the demise of ACD for case finding, better methods of malaria surveillance are urgently needed. For predicting epidemics and pockets of endemicity, satellite imagery and GIS offer hope, and are being explored over altitude in the HMP and over time in Gujarat/Rajasthan. Progress towards better methods of routine surveillance has been limited by the rarity of high standard reference data for population studies. We now have created three such situations in the longitudinal and cross-sectional surveys of rural and urban Surat and in a ground survey of 30,000 people in Yunnan. In these there are also routine PCD data and other measures of infection so we can assess performance as a basis for experimental improvements. Comparative analyses will form the basis for an exploratory workshop on surveillance.

A completed study of very low malaria incident areas of China has devised efficient simple criteria to reduce slides examinations greatly while missing few cases. These results are being used in policy decisions there.

In the worsening malaria situation among the Venezuelan Amazon indigenous population, two sympatric tribes surprisingly showed very different patterns of malaria, and causes are being sought. High level chloroquine resistance was detected, with all falciparum isolates virtually clonal, with implications for both treatment recommendations and future vaccine studies.

Most activities in the log-frame took place as planned, but a few were delayed by funding constraints. New projects not in the plan (P61-P65) were either promising developments from work in progress, new inventions requiring trials or new opportunities for collaborative work at the malaria/health systems interface. The overall consequence is to increase focus on the Programme's main themes and direct them towards implementation processes.

1.3 Publications

Publications are listed in Annex 1. Because the major activities in India are now producing results there will be many more from that area before the end of the programme. One important publication, currently in draft and being circulated for comment, is the manual on implementing ITMN projects. The efficacy of the simple vaporising anti-mosquito lamp is illustrated in Annex 7, Fig. 6 as the data are too recent to have yet been published.

1.4 Contributions to Policy and Strategy Development

Programme staff contributed substantially to policy development in a year that saw research interest in, and operational concern for, malaria increase markedly.

ITMN.Through the Malaria Consortium, Programme staff made a major contribution to the preparation and design of the USAID/MC 1997 Washington meeting which brought together all the major donors, national programme managers, CSO's, researchers, and manufacturers, and to the

WHO/AFRO meeting for national managers in Arusha where a promising collaboration was initiated. A review, prepared at the link adviser's request for DFID field managers, influenced subsequent WHO manuals and meetings.

In chemotherapy, BMG is a member of the WHO working group on artesunate suppositories for severe malaria, will chair the WHO meeting to review the artemisinins, is a member of the very active task force on 'Lap Dap', and of the committee to oversee Malarone donations to Africa.

On climate change, several Programme staff were invited to the series of meetings that planned GIS work for Africa, others were members of the group preparing a policy paper of the AAM and helped moderate the tone of debate in the USA.

All staff have participated in meetings (Tanzania, Gujarat, and particularly one supported by DFID in Nigeria) to develop national policy arising from research results.

1.5 Major Milestones

Particular milestones reached in the last year include:-

- Large community-randomized trial shows ITMN effective and superior to house spraying against *An. culicifacies* transmitted malaria in India.
- RTS,S vaccine trial in progress, SPf66 having been found ineffective.
- National ITMN programmes active in Tanzania and for Malawi, run by Programme-trained staff.
- African Highland Malaria study, phase one completed.
- Surat multidisciplinary urban study functioning.
- Major contributions to Hyderabad malaria meeting, with globally increased malaria profile, and to series of African Malaria Meetings and the MIM.
- Molecular methodology demonstrated feasible for assessing re-infection in clinical trials and strain pattern modification in vaccination trials.
- Programme staff continue as leading source operational expertise on ITMN implementation and manual in preparation.
- Use of El Niño to predict malaria reinforced.
- New method to reduce mosquito biting for the urban poor developed, tested and found efficacious.
- Dip-it-yourself methodology for re-treating ITMN now spreading and taken up commercially.
- Strong participation in Washington bed net meeting.

1.6 Risks

This year, several pieces of difficult field work have produced results. Civil strife in Liberia, then in Sierra Leone, has made work in these countries impossible but we remain hopeful of re-establishing indigenous work in both countries. In India, much effort was put into recovering from a major setback: the Surat project was seen as a step towards feeding into operational research in a major WB/ODA (now DFID) collaboration in malaria control in India, from which ODA unexpectedly withdrew, undermining our strategy in South Asia. The opportunities this seemed

about to provide were one reason for the scale of our commitment there. Funding for work in China may prove difficult.

1.7 Gender Issues

The brunt of malaria mortality and morbidity falls upon children and pregnant women, while both the incidence of malaria and its adverse effects are greater for poorer communities. Since stopping malaria transmission and preventing epidemics benefit all, and those at greatest risk benefit most, there is an inherent equity in malaria prevention at community level, when feasible.

Our work with bednet programmes has strong gender orientation in several respects: in Orissa manufacture has been through women's co-operatives, work on re-impregnation of ITMN has been developed with and for African women, and women and children who go to bed earlier gain most benefit from the protection afforded by ITMN. Specific studies have been completed on the interaction of malaria with micronutrient supplementation during pregnancy.

2. Dissemination

2.1 Targets

As control methods for malaria increasingly focus on the household , the range of users broadens and multiple routes must be used not only to convey conclusions but also to create a climate of concern for malaria. This extends from papers in widely read medical journals through to radio and television, where Programme staff have received wide exposure on the BBC Overseas Service, television, and on media in South Asia in relation to the Ross Centenary in summer 1997 in Hyderabad.

Access to national programme leaders, of particular importance in malaria with relatively centralized programme direction, is achieved at personal level (visits, consultancies) and regional workshops. Programme staff have played active roles at annual Southern Africa and at SEARO workshops; results have been presented. Programme staff sit on influential WHO (Geneva, TDR, AFRO) and related committees, whose advice is still considered authoritative in most endemic countries.

Programme staff are treated as the primary resource for expertise on applied aspects of the use of ITMN, especially in Africa. The Net Gain book, to which the Programme contributed a technical review, has already become the primary reference for treated net projects, and will soon be complemented by the Handbook for Project Managers. Staff contributed to the Consortium book for WHO on malaria for District work.

2.2 Utilization of Research Findings

Results of ITMN work have been utilized at many levels. Tanzanian efficacy trials led to the national ITMN programme there, utilizing work on social marketing data and expertise. The major implementation agency for national programmes in Tanzania and Malawi has now employed two former Programme staff to run their public health activities. This and our central input to the leading manuals on implementation influence all projects. The vaccine and drug trials have affected policy.

Our earlier work on ITMN trials in Solomon Islands has contributed to that country now having the world's highest coverage of ITMN, and the new Surat trial result will influence Indian thinking. The Programme pioneered individual net reimpregnation by sachets of insecticide, now manufactured commercially in Tanzania and the approach has now been taken up by several manufacturers.

Epidemic prediction is at an earlier stage in the research process, but a Programme presentation of data in Gujarat led to an (unsolicited) strong request from the State Health Minister to DFID for a much more extensive project leading into operations.

The work on global climate change effects on malaria tends to be seized upon widely as a basis for policy changes, and we are anxious to restrain its over-interpretation especially in the USA where the policy debate on global change has become unduly polarized.

3. Capacity Strengthening

3.1 Developing Countries

Whilst research capacity has been strengthened in all the countries where we have projects (Annex 2), as we have trained indigenous staff, the main capacity strengthening work in developing countries has been in India, the African Highland Malaria Network, and in Yunnan, China. Particular forms of assistance in preserving capacity have been provided for Sierra Leone and Liberia. Efforts have been completed in Northern Thailand and are increasing in Mozambique. The joint Programme Head has a longstanding special role in relation to The Gambia and its neighbours. Our intention for 1998-99 is to open up further capacity strengthening collaborations in East Africa, in addition to Tanzania, with AMREF in Kenya and with universities and the Health Ministry in Uganda.

Capacity has been greatly strengthened in Surat District (4 million population) at multiple levels. All planning and field work has been with State, District, Central Government and Municipal malaria staff of whom 850 have been trained. Closest relations have been with the Preventive Medicine Department at the Government Medical College whose entire staff have been drawn into different parts of the project and learned new skills. A resident Programme staff member is upgrading epidemiological work. The Social Science Institute has been brought into malaria work. A hands-on course for municipal engineers has involved them in malaria issues related to building. General Practitioners involved in the public/private mix research, organized a seminar (attended by over 140 doctors) in the City and are publishing the proceedings. Staff at all 4 levels from Central Government to municipality have been trained to doctoral and masters level (Indian bureaucratic delays have hindered some) and the Programme has also acted as a catalyst for internal growth locally.

In China where malaria expertise is scattered we have built on contacts formed at the SE Asian Border Malaria Workshop which we convened (and which led to the various nationalities attending staying in touch with each other). We trained senior staff of the Yunnan Malaria Institute, and several staff have become involved in a field GIS project by another trainee. The British Council have now supported a link with Yunnan so that the long-term process of capacity building can develop further.

In order to strengthen and broaden our African impact, especially in capacity strengthening, we have planned collaboration with AMREF to strengthen their research capacity through a joint analysis of migration and malaria in Kenya. To explore substantial development of work with Uganda, an assessment visit was made, accompanied by TDR staff, and we aim to develop work with both the Medical Schools and Ministry of Health.

The Programme will, in the coming year, do more work on both malaria control and capacity building in conflict and post-conflict situations. It mobilized support for the Bo laboratory in Sierra Leone after the UK MRC departed, carried out ITMN trials in the forest zone, now published, explored a national programme to implement the results with a CSO which was postponed due to civil war. One of our trainees still hopes to return. The Director of the Liberian IMR (temporarily

Programme staff) will return and restart malaria work. In an Asian post- conflict situation, where Programme staff have worked, the leader intends to come to write up his extensive refugee malaria control work, while a doctor previously attached to the Programme will take over his post.

3.2 UK and Europe

UK capacity in highly applied malaria has also been strengthened, through Programme staff appointments of 4 scientists without previous malaria experience. An entomologist mastered the subject, has produced important and useful manuals on both insecticides and ITMN programmes and he and a colleague have been recruited to lead implementation of national ITMN programmes in Tanzania and Malawi. The other three staff remain with the Programme but are now experienced in malaria anthropology, GIS and clinical epidemiology. They have concentrated on hands-on research under the Programme but are now taking a wider view and interacting with more agencies.

In Europe capacity in the more applied aspects of malaria research has been enhanced by five post-doctoral fellows, funded by the EU, attached to the Programme and participating in its work for around 9 months each. One has achieved an international reputation and remained with the Programme. Two have augmented malaria expertise in southern European institutes, and perhaps most gratifyingly, two are now participating in field operational research malaria programmes in Mozambique and Uganda. Staff also sit on European institutional review committees.

5. Process Issues

5.1 Interaction with other Work Programmes

A key interaction, with the Health Economics Programme at LSHTM, has gelled during the year and three important collaborative activities are taking place:

- an analysis of the complex public-private mix in malaria care provision in Surat city.
- providing the malariological input to an economic analysis, for the World Bank.
- working together on the economics and social marketing of bed nets in rural Surat, enabling the economist to test out willingness-to-pay assessments.

Joint projects with the Maternal Health Programme is being planned.

Relations with the Liverpool Malaria Programme have continued to become closer, with joint planning meetings. GIS activities are moving from being complementary to collaborative and joint discussions on malaria in pregnancy and on environmental management are taking place.

Most crucial have been relations with the UK Malaria Consortium. Links are on a daily basis with the Consortium both disseminating our results and providing advice on priority problems and groups in developing countries needing collaborative help. It has also been possible to share out representation at the very numerous malaria meetings currently being held. Staff take a little time out to do consultancies for the Consortium, consequently being able to feed new results into operational project design where appropriate. The Consortium has involved Programme staff in assistance to WHO/AFRO in particular, mainly in relation to ITMN, and this is likely to develop further.

5.2 Interactions with DFID Staff

Our relations with DFID staff have always been close, in India in relation to the work in Gujarat and Orissa and their Management Committees, as also in Tanzania with the Desk, in relation to the

transformation of our research into a National Programme funded by DFID. Interactions with other DFID staff in East Africa have increased as malaria becomes a higher priority. New staff have been briefed, and both the Link Adviser and other HPD staff are in regular touch. The Consortium staff also act as a link between us and DFID staff.

5.3 Collaboration with other agencies

Programme staff are represented on several committees and panels of WHO concerned with malaria, regularly visit Geneva and AFRO, and run a PEEM collaborating centre.. BG was a key member of the Dakar Conference Committee and the MIM managed from WHO. In capacity building we interact with TDR. Other examples are given above. EU have supported West African work and we have interacted over malaria in SE Asia.

6. Administrative Issues

The Programme has always had good interaction with DFID and the link adviser, though both we and they are very busy. We initially experimented with a non-standard workplan structure which has taken time to dismantle and reaggregate. In the annotated project structure 1998-98, attached here, the activities have been regrouped to fit the output structure. This is to harmonize the reorganized logical structure and does not alter content. Earlier versions are available for discussion.

Because the development of long-term multidisciplinary projects that combine research, capacity building and getting results operational, may need some familiarity to follow, annex 5 gives narrative accounts of some of these. An account of the Programme's effect on policy has been requested. This aspect is emphasised in the current report, and a paper on the topic follows shortly.

ABBREVIATIONS

AAM	American Academy of Microbiology
ACD	Active Case Detection
AMREF	African Medical and Research Foundation
BBC	British Broadcasting Corporation
BC	British Council
CSO	Civil Society Organization (formerly termed NGO)
DFID	Department for International Development
EIR	Entomological Inoculation Rate
ELISA	Enzyme-linked Immunosorbent Assay
ENSO	El Niño Southern Oscillation
EU	European Union
FO	Foreign Office
GIS	Geographical Information Systems
HMP	Highland Malaria Programme
IDRC	International Development Research Centre
IMR	Institute for Medical Research
ITMN	Insecticide Treated Mosquito Net
KEMRI	Kenya Medical Research Institute
LSTM	Liverpool School of Tropical Medicine
LSHTM	London School of Hygiene and Tropical Medicine
MARA	Mapping Malaria Risk in Africa
MC	Malaria Consortium
MIM	Multilateral Initiative for Malaria
MM	Fortnightly Malaria Programme Meeting at LSHTM
MoH	Ministry of Health
MRC	Medical Research Council
NIMR	National Institute for Medical Research (Tanzania)
NMEP	Indian National Malaria Eradication Programme
ODA	Overseas Development Administration (renamed DFID)
RTS,S	A candidate malaria vaccine
PEEM	Panel of Experts in Environmental Management
SKB	Smith, Kline Beecham
SP	sulphadoxine/pyrimethamine
Spf66	A candidate malaria vaccine made
TDC	The Work Programme on Tropical Diseases Control at LSHTM which preceded the MP.
TDR	Tropical Disease Research Programme of the WHO and partners
UK	United Kingdom
USAID	United States Agency for International Development
WARDA	West African Rice Development Association
WB	World Bank
WHO	World Health Organization
WHO/AFRO	WHO Regional Office for Africa
WHO/SEARO	WHO Regional Office for South-East Asia
WRAIR	Walter Reed Army Institute for Research

ANNEXES

Staff List

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2. Collaborations with Overseas Institutions

3 Complementary Funding

4 Logframe 1997-98 annotated

5 Narrative accounts of some main work foci
- 5A Nets in Tanzania
- 5B Urban Surat
- 5C Highland Malaria

6 Financial Reports

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PROJECT PORTFOLIO & PROGRESS REPORTS

List of Projects

Project list by Section of Report

Project list by Country

Project list by Project Number

Project outlines and progress summaries for P1 through P65
(Projects that were completed or discontinued more than a year ago are omitted).

Staff Involved with the Programme

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ANNEX 1

PUBLICATIONS 1997-1998 ON MALARIA OF DFID PROGRAMME STAFF

1997

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Clinical diagnosis of malaria: uses and limitations of signs and symptoms based algorithms.

Beliefs and behaviours of migrant populations: its implications for urban malaria control.

Acceptability and sustainability of an insecticide-treated bednet programme in an urban area.

Methods for assessing quality of care of malaria in public and private sectors: issues in their development.

Quality of care of malaria in public and private sectors in an urban setting in India.

ANNEX 2 COLLABORATIONS WITH ORGANIZATIONS OUTSIDE THE TWO SCHOOLS OF TROPICAL MEDICINE

Institutions	Topic of Collaboration	Training	Enhancement of Capacity where relevant
The Gambia ●Medical Research Council Laboratories, Fajara ●Ministry of Health	SPf66 vaccine follow-up, *P1* Diagnosis by village health wkrs, *P6* Trial of new antimalarial, *P8* Trial of RTS,S vaccine, *P47*	An EC Fellow learned the molecular methodology involved	Trial design skills were learned by the team Use of clinical scoring as a method introduced Trial methodology for a vaccine learned
Tanzania ●Tanzanian National Institute for Medical Research, Ifakara Field Station ●Muhimbili Medical University ●Population Services International ●National Institute for Medical Research ●NIMR - Muheza - Amani ●Ministry of Health ●National Malaria Control Programme	Vaccine trial of SPf66, *P2* Reimpregnation of net methods, *P11* Design of Social Marketing, *P43* Strategies Trial of alphacypermethrin, *P59* Highland malaria study Social marketing of nets and insecticide: project design, monitoring and evaluation		Monitoring skills Social science methods learned. There has been continuous involvement in the field with staff of NIMR, especially at Muheza and Amani over many years, with one Programme staff member living there and two more visiting frequently.
Sierra Leone ●Malaria Field Station, Bo	Bednets and spatial aspects of malaria, *P33*	2 PhD's in epidemiology	Teaching how to design and run a community randomized trial Maintaining skilled staff during emergency
Rwanda ● Programme National de Lutte Contre le paludisme/Rwanda	Assistance with net treatment programme, especially design and evaluation of net-treatment strategies, through Malaria Consortium consultancy.		This was a short consultancy that introduced a behavioural science approach to work with ITMN by the National malaria programme.

Institutions	Topic of Collaboration	Training	Enhancement of Capacity where relevant
Madagascar ●Institut Pasteur de Madagascar ●ORSTOM ●Ministry of Health	Highland malaria study	Workshop	Developing network for GIS
Ethiopia ●University of Addis Ababa ●National Malaria Control Programme ●International Livestock Research Institute ●Malaria and other Vector Borne Diseases Unit, MoH ●Amhara Regional Health Bureau	Pregnancy and malaria, *P7* Failure of chloroquine treatment, *P9* Effects of altitude and climate change, *P29* Indoor and outdoor climate, *P30* Early warning system in highlands, *P25* Collaborative study of microclimate in vector resting sites Highland malaria study	PhD (PhD)	Epidemiology training project (*P7*) A second training project combined epidemiology with climate studies in an epidemic area. Developing network
Uganda ●Malaria Control Unit and Vector Control Division, MoH ●National Biomass study/Forest Dept ●Makerere University ●Ministry of Health	Highland malaria study Training. Planned capacity building Training. Planned capacity building	 2 MSc's	Developing network Laying basis of long-term capacity building across several departments; malaria trainee identified also.
Mozambique ●Ministry of Health ●Instituto Nacionale de Saude ●Population Services International (PSI)	District level for bednet distribution, *P13*	PhD	Introduced 'action research' into a district level ITMN programme. Have also built capacity in the CSO to run programme.

Institutions	Topic of Collaboration	Training	Enhancement of Capacity where relevant
Kenya ●Division of Vector Borne Diseases, MoH ●KEMRI ●International Centre of Insect Physiology & Ecology ●ICRAF/African Highlands Initiative ●Dept of Zoology, University of Nairobi ●AMREF	Highland malaria study Highland malaria study Highland malaria study Highland malaria study Studies of migration and malaria being planned		)))) Network developing)) The aim is to increase AMREF research capability by joint planning and execution of migrant studies from late 1998.
Mali ●Department of Parasitology & Applied Entomology	Irrigated Rice Ecosystem study, *P23*	(PhD)	Study design & analysis of institutional changes in disease control.
Cote d'Ivoire ●West African Rice Development Assn. ●Institute Pierre Richet, Bouake	Irrigated Rice Ecosystem study, *P23*		Study design & analysis; greater ability to think and work intersectorally.
Zimbabwe ●International Union for Conservation of Nature, Harare ●Ministry of Health	Wise use of wetlands, and malaria, *P31* Malarial placental HIV transmission, *P49* [Evaluation of Sick Child Algorithm], *P51*		Interdisciplinary work
South Africa ●South African Institute for Medical Research ●MRC of South Africa ●National Malaria Programme	African Highland Malaria Population Structure of *An. Gambiae, P52*	 PhD	Research Collaboration Research Collaboration

Institutions	Topic of Collaboration	Training	Enhancement of Capacity where relevant
Many African •Centres throughout Africa	Epidemiology of highland areas, *P57*	Workshops	GIS skills for many African centres
Papua New Guinea •Institute for Medical Research	Recombinant Vaccine Trial, *P3*		Monitoring skills
India •National Malaria Eradication Programme. •Malaria Research Centre, ICMR. •Department of Preventive & Social Medicine, Govt Medical Coll., Surat. •Government of Gujarat. •Centre for Social Studies, University of South Gujarat. •MRC Field Station, Nadiad. •College of Engineering, Surat. •Sachin Training College. •British Council, Bombay •Surat City Council	Urban migrant study, *P4* Clinical Predictors of Malaria, *P5* Entomological Evaluation of Trial, *P12* Trial against *An. Culicifacies* malaria, *P19* Urban bednet delivery study, *P21* Cost effectiveness (with HEP), *P45* Willingness to pay (with HEP), *P46* Public-Private mix (with HEP), *P48* [Incorporation of nets into policy], *P60*	MSc, In service 2 PhD's 3+ MSc's Several local MDs 848 local trainees	Social Research Skills Clinicians all levels Entomology field teams Extensive training and work on many topics This is an in-depth building of capacity in government, municipality and Medical College for all concerned with malaria in Surat District
•Government of Orissa •CARE, Orissa •MRC Field Station, Orissa •British Council, Delhi	Orissa treated bed net project, *P17*		Design of trials
•National Malaria Eradication Programme •Malaria Research Centre, ICMR.	Control of malaria during pregnancy, *P20* Epidemic forecasting, *P26*	Graduate training	Large scale trial design and implementation; strengthening analytical capacity.
China •Ministry of Public Health, Beijing •Institute of Parasitic Diseases, Hubei •Yunnan Malaria Institute	New surveillance system for following low level malaria, *P35* Remote sensing in Malaria Control, *P55*	PhD, MSc	New epidemiological skills GIS

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Institutions	Topic of Collaboration	Training	Enhancement of Capacity where relevant
Myanmar •National Malaria Programme	Use of traditional bednets in control, *P16*		New methodology for national programme
Solomon Islands •UK Foundation for the South Pacific •Solomon Islands Development Trust	Implementation of bednet policy, *P18*	All senior staff had been trained earlier by us (MSc, PhD)	Project Design concepts taught to the CSO.
Indonesia •Gadjha Mada University	Malaria during pregnancy, *P50*	PhD	A clinical pharmacologist is learning how to do field epidemiology.
Colombia •Centre for climate research, Medellin	Early warning system in highlands, *P25*		Research Collaboration, complementary skills.
Venezuela •National Institute for Health, Caracas •CAICET, Amazon Trop Dis Centre	Early warning system in highlands, *P25* Malaria among the Yanomani, *P34* Treated nets in Upper Orinoco, *P39*	PhD	Research Collaboration Molecular Epidemiology being learned by doctoral student with biology background.
Brazil •University of Rio de Janierio	Remote sensing of forest malaria, *P27*	PhD	Doctor from Amazon was able to learn GIS and has taught it widely on return.
Multiple Countries •Multiple overseas programmes	Survey of operational net experience, *P10*		Shared Experiences between 20+ projects worldwide.
Canada •McGill University of Montreal	Pregnancy and malaria, *P7*	PhD for Ethiopian	Though funded by McGill, the student was from the University of Addis Ababa and learned epidemiological skills.
Switzerland			Scientific collaboration in Tanzania.

Institutions	Topic of Collaboration	Training	Enhancement of Capacity where relevant
•Swiss Tropical Institute,Basel •University of Geneva	Vaccine trial of SPf66, *P2* Historical Analysis of Malaria Policy, *P38*		Learned Monitoring skills (Interdisciplinary work - taught us much.)
Spain •Unidad de Epidemiologia, Barcelona	Vaccine trial of SPf66, *P2* Historical epidemics in India, *P56*	EC Fellow	Field workers improved their Monitoring skills and ability to run trials. Historical Epidemiology: Field epidemiologist learned a completely new field.
Portugal •University of Lisbon	Molecular Immunology	EC Fellow	Molecular Epidemiology
Germany •University of Munich •University of Tubingen	Genetics of Parasite variation, *P1* Genetics of Parasite variation, *P61* Epidemiological modelling, *P58*	2 EC Fellows	Malaria and Molecular Epidemiology studied by both but they also picked up a field approach and one is now in the tropics.
Ireland •College of Surgeons, Dublin	El Nino effects on Malaria, *P25,26,28*	EC Fellow	Broadened knowledge of Malariology and research work.
Netherlands •University of Maastricht	Predicting climate effects on malaria, *P28*		Collaboration with mathematician who became more aware of practical aspects of malariology.
Denmark •Statens Serum Institutet	Bed net trials in Sierra Leone, *P33* Net distribution at District Level, *P13*	(PhD)	Danish PhD learned some aspects of trial management and use of GPA Field Management methods learned by local workers
UK •University of Oxford: Zoology Dept •University of Oxford: Wellcome Unit	GIS in relation to Malaria in Africa Historical Aspects of malaria control in East Africa		Beginning research collaboration Complementary skills

Institutions	Topic of Collaboration	Training	Enhancement of Capacity where relevant
•University of Oxford: Institute of Molecular Medicine •International Institute for Environment and Development (IIED)	Trials of Malaria Vaccines Agricultural Development, Vectors, and Malaria.		Complementary expertise IIED learn health issues and malaria from us. We get better feel for agricultural work.
USA •Johns Hopkins School of Public Health •Walter Reed Army Hospital, Washington	Climatic early warning systems, *P25* Trial of RTS,S Malaria Vaccine, *P47*		Research Collaboration, bringing different perspectives.
WHO •TDR, Geneva	Longstanding collaboration, especially in training numerous doctoral fellows. Earlier originated the "sandwich" system, which is now universally used. Work with Research Strengthening Grant system.		
•CTD, Geneva	Numerous formal and informal interactions since 1965, and continuing.		
•WHO Pesticide Evaluation Scheme (WHOPES), Geneva	Various formal and informal consultations, including evaluation of alphamethrin on nets in Vietnam and Tanzania, editing updated version of standard handbook on chemical control methods, and methods of insecticide testing.		Bring expertise from close to the field.
•AFRO	Links continue to develop through Malaria Consortium, e.g. co-ordination of inter-country evidence-based drug policy, implementation strategies for treated nets.		Mutual education from working together.
•SEARO	Longstanding links with malaria control programmes in both regional office and countries in the region.		

Complementary Funding

Proj.No.	Topic of Project	Total Funding	Through School	Related
P1	Follow-up of children immunised with the malaria vaccine SPf66.	316475	60000	
P8	A randomised placebo controlled trial of the new anti-malarial CGP 56697 in Gambian children.	100000	10000	
P10	A survey of operational experiences of using pyrethroid-impregnated mosquito nets.	74000	74000	
P11	Development of a "dip-it-yourself" kit for home treatment of mosquito nets in Dar-es-Salaam.	144841	144841	
P11	Development of a "dip-it-yourself" kit for home treatment of mosquito nets in Dar-es-Salaam.	17000	17000	
P11	Development of a "dip-it-yourself" kit for home treatment of mosquito nets in Dar-es-Salaam.	13000	13000	
P11	Development of a "dip-it-yourself" kit for home treatment of mosquito nets in Dar-es-Salaam.	100000	100000	1900000
P13	District level systems for distributing nets and insecticide for impregnation.	75000	45000	
P18	Promotion of impregnated bednets in Solomon Islands.			215000
P23	Effects of irrigated rice agroecosystems on the amount of malaria in West Africa.			1800000
P25	Using the El Nino as possible early warning system for epidemic malaria in highland areas.	10000	10000	
P34	Epidemiology and drug resistant malaria amongst the Yanomami and Yekwana.	45000	45000	
P39	A trial of treated nets against malaria in the Upper Orinoco.	75000	45000	
P40	Development of an ELISA for measuring pyrethroid deposits on mosquito nets.	16269	16269	
P40	Development of an ELISA for measuring pyrethroid deposits on mosquito nets.	1000	1000	
P47	A trial of the malaria vaccine RTS,S.	562000	162500	
P50	Epidemiology of malaria during pregnancy in Indonesia.	60000	45000	
P52	Population structure of An.gambiae in South Africa.	181850	181850	
P55	Prediction in China.	50000	45000	
P57	The epidemiology of highland malaria in Africa.	87500		
P59	Comparative trial of nets treated with alphacypermethrin or lambdacyhalothrin at Muheza.	62500	62500	
ECF	European Community Fellows	165000	165000	
P15	Guidelines for Engineers on Urban Vector Control	8750	8750	
	Effects of global climate change, Johns Hopkins	6250	6250	
	Studies of climatic change and malaria, EPRI	48100	48100	
P8	Genetic Studies on patients treated with CGP 56697	13000	13000	
Surat	Malaria Research and Control Project (comprising many subprojects)	4622000	789000	

Overseas funds converted at $1.6=£1; Ecu 0.75=£1

MALARIA PROGRAMME:
PROGRESS RECORD
LOGFRAME 1997-1998

	Activities	Stage Reached and Verifiable Indicators. Progress to March 1998	Proj
1.	**MALARIA PREVENTION AND MANAGEMENT**		
1.1	**Insecticide-Treated Bed Nets**		
1.1.1	**Nets in East Africa**		
a	"Dip-it-yourself" kit for Dar-es-Salaam	Small-scale sachet production established; Swahili instruction developed and tested. Kit design adopted in 2 large social marketing projects. Papers at final draft.	P11
b	Methodology	The methodology for developing and testing locally appropriate instructions for use in kits for the home treatment of mosquito nets has been produced and has been utilized by programmes in several countries in Africa (Tanzania, Rwanda and Malawi). It will form part of the DFID Handbook for Project Managers to be distributed to District Health Management Teams and Project Managers throughout Africa and S.E. Asia	P11
c	Social marketing strategies for Tanzania	Monitoring and evaluation strategy designed, indicators defined, tools developed to pre-pilot stage. [Report]	P43
d	District level systems for distributing nets	Collaborators for PSI project identified, stake-holder workshop	P13

ANNEX 4

1.1.2	**Technical improvement of treated bednets**		
a	Trial with alphacypermethrin at Muheza	Nets treated with alphacypermethrin (20mg/m^2) or lambdacyhalothrin (10mg/m^2) have been compared in 12 villages near Muheza. The number of infective bites per night was reduced by 99% among those who slept under nets treated with either insecticide. The incidences of malaria infection were reduced by 74% and 73% respectively in villages where alphacypermethrin-treated or lambdacyhalothrin-treated nets were tested. A preliminary report of these findings has been made to WHOPES.	P59
b	Field trial of Alphamethrin in Vietnam	Project visit completed; recommendations made (project has design problems, no further involvement).	P42
c	ELISA for measuring pyrethroid deposits active	Polyclonal pilot test functional. De-bugging of procedures and screening for monoclonal underway.	P40
d	Risk assessment of pyrethroid exposure on nets	Funds secured; terms of reference being drawn up.	P41
1.1.3	**Survey of operational experience of nets**		
a	Field work	Completed - more than 20 projects visited.	P10
b	Report and paper	Book drafted, being edited.	P10
c	Workshops communicate results	Planned.	P10
1.1.4	**Operational Trials of Treated Bednets**		
a	Orissa. ITMN Project	Third year evaluation showed that ITMN promoted and treated by tribal women are still reducing malaria. Project completed. Proceedings of evaluation workshop written up, paper in preparation.	P17
b	Use of traditional bednets in Myanmar active	70% use of nets, purchased at market prices, achieved by health promotion programme. Project completed and written up. Paper submitted.	P16
c	Promotion of nets in Solomon Islands active	Research on ITMN changed policy; now programme of net promotion. Promotion project in progress.	P18
d	A trial of nets in the Upper Orinoco active	Against *Anopheles darlingi*, and so of particular interest. Baseline survey complete. Intervention May 1998.	P39

1.1.5	**Efficacy Trials of Control in Rural Surat**		
a	Rural malaria control trial, Surat	Preliminary results showed that ITMN were almost twice as effective as residual wall spraying in reducing malaria.	P19
b	Rural malaria control trial surveillance, Surat	Effective system for detecting all new positive cases of malaria set up which will subsequently be used to evaluate existing surveillance programme.	P19
c	Cost effectiveness of nets vs spray (HEFP)	Data collected and being analysed, but suggest that ITMN will be much cheaper than residual wall spraying.	P45
d	Entomological evaluation in Surat	Data collection and entry complete.	P12
e	Willingness to pay for bednets (HEFP)	Acceptance by community that they are prepared to buy nets at a subsidised price of approximately £1.25 per net.	P46
1.2	**Vaccine Trials**		
a	A trial of the malaria vaccine RTS,S	A trial of the circumsporozoite *P.falciparum* vaccine RTS,S was started in The Gambia in 1997 but was halted prematurely because of problems with vaccine stability. The trial is being repeated. Approximately 300 adult Gambians will complete a 3 dose course of immunisation in August 1998 and they will then be monitored throughout the 1998 malaria transmission season. Preliminary results from this trial should be available early in 1999.	P47
b	Follow-up children immunised with SPf66	Lab studies on samples collected during the Gambian SPf66 trial have been completed. These have shown that Gambian children made a good antibody response to the vaccine so that this was the reason for the failure of the vaccine to protect. Molecular biological studies have shown fewer 'strains' of *P.falciparum* in children who received SPf66 than in the controls suggesting that the vaccine did reduce the incidence of infection although not to a sufficiently marked degree to reduce clinical infections. Two papers submitted.	P1
c	The Ifakara SPf66 Vaccine Programme	This trial, in which Tanzanian infants have been immunised with 3 doses of SPf66 given in conjunction with routine EPI vaccines has progressed exactly according to plan and is due to finish in October 1998. BG made a second visit to study in his capacity as WHO monitor for this trial in September 1997. The trial is being conducted to a very high standard.	P2
d	Vaccine Trial in Papua New Guinea	Monitoring continued. Vaccine administered and minor adverse events recorded.	P3

1.3 1.3.1 a	**Malaria Management** **Chemotherapy** Trial of anti-malarial CGP 56697 in Gambia	Pre-registration trials of this new combination antimalarial (artemether + benflumetol) including a comparative trial with Fansidar undertaken in The Gambia have been completed. Trials undertaken at several sites in Asia and Africa have shown this to be a promising new anti-malarial. Its registration is now under review.	P8
b	Advice on Malarone Use in Tropics	Glaxo Wellcome has generously offered to provide up to one million courses of Malarone, a highly effective but expensive new antimalarial, free to countries where it cannot be afforded. The Task Force for Child Survival based in Atlanta has been given the task of deciding how this donation can be used in the most effective way. BG is a member of the advisory committee which has met twice during the past year, in London and Nairobi. Conditions in which it would be appropriate to use Malarone in endemic countries have been established and a small donation programme has started in Kenya.	
1.3.2 a	**Malaria in Pregnancy** Malaria during pregnancy in Indonesia	Data collection started in Nov. 97 and the results will be available in early 1999	P50
b	Control of malaria during pregnancy	A project proposal was developed, but the study was not carried out due to unavailability of funding	P20
c	Iron and malaria in rural Ethiopia	A study undertaken in NW Ethiopia determined the response of children and women with a low haemoglobin level to supplementation with oral iron. A good haematological response was obtained in both groups. A small but significant increase in febrile illnesses and in febrile illnesses associated with malaria parasitaemia was observed in women and in children. Overall, the benefit from iron supplementation outweighed its effect on malaria but, whenever possible, iron supplementation should be accompanied by malaria control measures.	P7
d	Placental malaria on transmission of HIV	The project proposal was not successful in obtaining funding even though it was recommended for funding by majority of reviewers (3/4)	P49

1.3.3	**Clinical Management at the Periphery**		
a	Clinical predictors to diagnose malaria	Data collection started in June 97 and the results will be ready for dissemination in December 1998	P5
b	Diagnosis of malaria by village health workers	Analysis of a study in which Gambian field workers used a scoring system to determine the likelihood that an individual child had malaria has been completed. Using this approach sensitivities and specificities of around 70% were obtained and the diagnostic ability of field workers was raised to that of an experienced paediatrician working without lab support. A paper describing these findings has been submitted.	P6
c	Sick child algorithm & chloroquine resistance	The project proposal was not successful in obtaining funding	P51
1.4	**Epidemic Prevention**		
1.4.1	Using the El Nino as early warning system	Historical analyses of Colombian and Venezuelan datasets have been completed and results published in two papers.	P25
1.4.2	Epidemic forecasts in Gujarat, India	Satellite imagery and malaria data have been collated and analysed; a concept note to extend this work with Indian collaboration is in preparation.	P26
2.1	**UNDERSTANDING MALARIA UNDER CHANGED CONDITIONS**		
2.1.1	**Urban Malaria in South Asia**		
	Integrated Study of Surat City		
a	Urban Surat: Bednet Trial	Data on attitudes towards bednets and willingness to pay has been collected and incorporated into the development of the campaign for the promotion of bednets. The NGO's have been trained and will start bednet marketing in June 1998.	P21
b	The public-private mix in urban India	Key stakeholders fully involved in process. Expert subcommittees set up to explore and make recommendations on key technical issues for consideration at a workshop on proposed interventions. Start of pilot interventions proposed for late 1998.	P48
c	Urban Surat: Migrant worker study	Data on beliefs and behaviours of migrant groups concerning malaria has been collected and is being incorporated into the development of a community health education campaign. ACD and the monitoring of migrant movement is on-going.	P4
2.1.2	Guides for engineers on urban vector control	Funding received in May 1998. Illustrations (a key aspect) completed and text to be written before 1999.	P15

2.2	**Climate Effect on Malaria**		
a	Epidemiology of highland malaria in Africa	First phase of spatial modelling and validation of malaria risk now completed and workshops to communicate results and plan future surveillance activities have been planned.	P57
b	Transmission in the highlands of Ethiopia	One paper published; key papers under revision.	P29
c	Microclimate and temperature variability	Detailed temperature data for an 18 month period have now been collated.	P30
d	Malaria in historical India	Punjab work completed and published as thesis Phase II deferred because of current field work and may be done by Dr Whitcomb.	P56
e	Modelling global change for endemicity	This collaborative application with a Dutch group to EU was not funded as peripheral to scope of the call. It will be superseded by newer projects.	P28
2.3	**Development Effects on Malaria**		
a	Effects of irrigated rice agroecosystems	Short account published, many papers drafted by Malian group and now good data from Côte d'Ivoire.	P23
b	Malaria control and wise use of wetlands	A rapid assessment of effects of wetlands conversation in Malawi and Zambia was carried out. Since the control of schistosomiasis and increasing accessibility to primary health services were identified to be the priority issues, no proposal to study the effects on malaria was developed.	P31
c	Remote sensing in malaria epidemiology	Field work completed, but little progress. Student has other concerns.	P27
d	Epidemiology of drug resistance in Yanomami & Yekwana, Venezuelan Amazon	Different impact of malaria by ethnic group found and a high degree of chloroquine resistance, the first line antimalarial used in the area. Analysis of risk factors for malaria exposure and drug resistance genetic associations are in progress. Both will influence local malaria control policies.	P34
2.4	**Surveillance**		
a	Remote sensing for surveillance, China	Phase 1 field work done, written up and field phase II being implemented. Funds from TDR.	P55
b	Surveillance strategy for low level malaria	In areas of low prevalence it is more efficient to concentrate on taking blood slides from those with clinical malaria or likely to have malaria. Study completed, written up and published.	P35
c	Use of 'postcoding' for malaria surveillance	This has not been taken forward.	P37
3.	**MALARIA CONCEPTS, POLICY AND IMPLEMENTATION**		

3.1 a b	**Policy Development** Historical analysis of malaria policy Collaboration with Consortium	Phases I and II published and concepts for III clear. Paper being drafted. Actively continued and developed to mutual benefit (see text)	P38
3.2 a b c d e	**Concepts and Basic Epidemiology** Microdistribution of malaria in Bo Population structure of *A.gambiae* in S. Africa Long-term epidemiological consequences of bed nets addressed Developing conceptual basis for comparing control approaches Mathematical models of falciparum malaria	 Results in draft form. Excellent progress in field: Field collection successfully carried out and intervention trial designed. Molecular biology/lab analysis moving ahead. Study under way in Burkina Faso with GATT and BMG. First developing overall framework with research student working on decentralization. Data may be provided to Klaus Dietz.	 P33 P52 P58
3.3	**Getting results into operational practice**	[treated for 1997-98 as an integrated part of each project]	
4.	**CAPACITY BUILDING IN DEVELOPING COUNTRIES, UK AND EUROPE**		

4.1	**Programmes Strengthened**	See also Annex 2 and text.	
a	Indian collaboration	Intensive training given to all levels of malaria staff of Gujarat state and NMEP. Department of Preventive and Social Medicine equipped and strengthened with in-service training and collaborative research.	
b	Programme with Tanzania	Development of public/private interface.	
c	Work with Yunnan	New British Council link, collaborating field work with Institute and large survey.	
d	Programme with Zimbabwe	With changes of malaria chief arrangements deferred.	
e	Programme with The Gambia	The Programme has helped to strengthen the ability of staff at the MRC Laboratories, The Gambia and the Ministry of Health to undertake malaria vaccine trials in The Gambia. It has provided statistical and general support to Dr Bojang, principle field investigator of the SPf66 and RTS,S trials.	
f	Work with one other national programme	Visit to Uganda (accompanied by TDR). Extensive discussions. Good time for partnerships and we could help bring government and Makerere closer, and bridge some departments at Makerere. Large malaria problem only handled in West. Potential doctoral student to be supported by TDR.	
g	11 research students in training		
h	2 new research students	2 new students have joined the group.	
I	1+ research student completes training	2 theses submitted and examined.	
4.2	**Research Training** 5 EC research fellow's work	All did good work, publications still coming out from it.	
4.3	**Teaching** GIS in malaria teaching module	Developed in multidisciplinary way. Much larger attendance than in previous year.	

MALARIA PROGRAMME

WORK PLAN LOGFRAME 1997 - 1998

Objectives	Verifiable Indicators	Means of Verification	Important Assumptions
Goal: 1. Reduced mortality, morbidity and suffering due to malaria and reduced transmission in a sustainable way in endemic and epidemic situations	1.1 Lower incidence and prevalence of malaria - specific mortality. Less malaria epidemics. Countries committed to malaria control and appropriate resources and staff allocated centrally peripherally and internationally.	1.1 National and global health statistics on malaria; results of surveys; reports of health ministries; political statements at e.g. W H Assembly, reports of international agencies, aid programmes.	Inputs: Budget: 1.6K Researchers: Bradley, Greenwood, Webber, Lines. Jones, Chandramohan, Cox, Marbiah, with Chavasse, Bouma on grant funding; Priestley: Admin. and Secretarial Mitchell: Secretarial Overseas collaborators, especially in India and Tanzania Researchers on other grants.
Purpose: 1. Better methods available for malaria control and put into both policy and practice together with increased capacity for applied malaria research and control operations in developing countries.	1.1 Incorporation of new methods into the policy statements and operating practices of developing countries; more research and better control plans by endemic countries.	1.1 Policy documents; National Plans; Publications of endemic country nationals; work programme of UK Malaria Consortium; involvement of Programme staff in key advisory committees and as advisers.	(purpose to goal) 1.1 Political will and stability. Adequate resources. Career structures for national research workers. Effective general health services.
Outputs: 1. Improvements in and results of trials of methods to control prevent and manage malaria at community and individual levels, especially 1.1) insecticide treated bed nets 1.2) vaccines 1.3) methods of case management 1.4) epidemic prevention.	1. - 3. Results of work published in peer-reviewed journals; involvement in work on new methods; request for advice from agencies and membership of advisory committees; requests from countries to help conduct studies; use of methods developed by Programme for other studies; request to assist operational programmes; research grants awarded.	1. - 3. Annual report of Programme, and of Malaria Consortium; Published papers; books; conference proceedings.	1. - 3. Use of results by policy makers. Adequate funding for workshops, conferences, production of popular literature to communicate practically useful results. Sufficient incentive for manufacturers to produce new products and funding for adequate trials

2. Better understanding of malaria under changing conditions as a basis for control, especially 2.1) urbanization 2.2) climate effect on malaria 2.3) land and water development 2.4) surveillance methods 3. Formulation of concepts, control policy and practical implementation at levels of; 3.1) policy development 3.2) conceptualization 3.3) getting results into operational practice.	(1. - 3. Results of work published in peer-reviewed journals; involvement in work on new methods; request for advice from agencies and membership of advisory committees; requests from countries to help conduct studies; use of methods developed by Programme for other studies; request to assist operational programmes; research grants awarded.)	(1. - 3. Annual report of Programme, and of Malaria Consortium; Published papers; books; conference proceedings.)	1. - 3. Use of results by policy makers. Adequate funding for workshops, conferences, production of popular literature to communicate practically useful results. Sufficient incentive for manufacturers to produce new products and funding for adequate trials.)
4. Building applied research and operational capacity in developing countries and Europe.	4. Number of operational and research programmes collaborated with and depth of involvement. Numbers of PhD, MSc, and others trained.	4. Annual report of Programme and research report of School; National malaria plans and reports of developing country institutions.	4. Career structures in research and in public health in developing countries improved. Employment conditions favour applied as well as basic work.

	Activities	Stage reached and Verifiable Indicators	Proj.	Means of Verification	Important Assumptions
1	**MALARIA PREVENTION**				
1.1	**Insecticide-Treated Bed Nets**				
1.1a	Nets in East Africa				
	"Dip-it-yourself" kit for Dar-es-Salaam	written up	P11	Papers	Accepted for Publication
	Methodology	documented	P11		
					PSI continue to work with
	Social marketing strategies for Tanzania	monitored	P43	Annual Report	us
	District level systems for distributing nets	In Progress	P13		Collaborators of SSI
1.1b	Technical Improvement of Treated Bednets				
	Trial with alphacypermethrin at Muheza	results in	P59	Annual Report	
	Field trial of Alphamethrin in Vietnam	monitored	P42		
	ELISA for measuring pyrethroid deposits active	In Progress	P40		Technical feasibility
	Risk assessment of pyrethroid exposure	funds sought	P41		Funds available
1.1c	Survey of operational experiences of nets.				
	Field work	completed	P10		
	Report and paper	written	P10	Papers	
	Workshops communicate results	workshop held	P10		Funding available
1.1d	Operational Trials of Treated Bednets				
	Orissa . ITMN Project	written up	P17	Papers	
	Use of traditional bednets in Myanmar active	In Progress	P16	Annual Report	Potential stasis
	Promotion of nets in Solomon Islands active	In Progress	P18		
	A trial of nets in the Upper Orinoco active	In Progress	P39		
1.1e	Efficacy Trials of Control in Rural Surat				
					Levels of malaria
	Rural malaria control trial, Surat,	interventions done	P19	Annual Report	appropriate
	Rural malaria control trial, Surat,	surveillance reliable	P19		Supervision manageable
	Cost effectiveness of nets vs spray (HEFP)	In Progress	P45		
					Adequate mosquito
	Entomological evaluation in Surat.	Revised sites	P12		populations
	Willingness to pay for bednets (HEFP)	In Progress	P46		

	Activities	Stage reached and Verifiable Indicators	Proj.	Means of Verification	Important Assumptions
1.2	**Vaccine Trials**				
1.2a	A trial of the malaria vaccine RTS,S.	First Results available	P47	Report and Papers	No adverse reactions
1.2b	Follow-up children immunised with SPf66.	Published	P1	Publication	
1.2c	The Ifakara SPf66 Vaccine Programme	Monitoring continued	P2	Report	Funding continues
1.2d	Vaccine Trial in Papua New Guinea.	Monitoring continued	P3		Funding continues
2	**MALARIA MANAGEMENT**				
2.1	**Chemotherapy**				
2.1a	Trial of anti-malarial CGP 56697 in Gambia	Written up	P8	Papers	
2.1b	Advice on Malarone Use in Tropics	Continue to assist		Annual Report	No adverse effects
2.2	**Malaria in Pregnancy**				
2.2a	Malaria during pregnancy in Indonesia.	Active	P50	Annual Report	Enough patients at site
2.2b	Control of malaria during pregnancy	Seek funding	P20		
2.2c	Iron and malaria in rural Ethiopia.	Accepted for publication	P7	Papers	Papers accepted
2.2d	Placental malaria on transmission of HIV.	Funded	P49	Annual Report	Funding available
2.3	**Clinical Management at the periphery**				
2.3a	Clinical predictors to diagnose malaria	Funded	P5	Annual Report	Indian collaboration
2.3b	Diagnosis of malaria by village health workers	Published	P6	Papers	
2.3c	Sick child algorithm & chloroquine resistance.	In progress	P51		Funding obtained
2.4	**Urban Malaria in South Asia**				
2.4a	Integrated Study of Surat City			Annual Report	Indian collaboration
	Urban Surat: Bednet Trial.	Operational	P21		Appropriate malaria levels
	The public-private mix in urban India.	Funded and Operational	P48		Field organizations
	Urban Surat: Migrant Worker Study	Operational	P4		
2.4b	Guides for engineers on urban vector control.	Over half written	P15	Draft Papers	PEEM funds available

	Activities	Stage reached and Verifiable Indicators	Proj.	Means of Verification	Important Assumptions
3	**CHANGING EPIDEMIOLOGY**				
3.1	**Epidemic Prevention**				
3.1a	Epidemiology of highland malaria in Africa	Fully Operational	P57	Annual Report	IDRC and other funds continue
3.1b	Transmission in the highlands of Ethiopia.	Published	P29	Publications	Papers accepted
3.1c	Microclimate and temperature variability	Data Analysed	P30	Data available	
3.1d	Using the El Nino as early warning system	Stably funded and active	P25	Annual Report	
3.1e	Epidemic forecasts in Gujarat, India.	Funded and Operational	P26		
3.1f	Malaria in historical India.	1st part completed; 2nd funded	P56	Dissertation	
3.1g	Modelling global change for endemicity	Funded by EC, or sought	P28	Annual Report	EC funds study
3.2	**Development Effects on Malaria**				
3.2a	Effects of irrigated rice agroecosystems	Phase 1 written up, Phase 2 progress	P23	Draft Papers	
3.2b	Malaria control and wise use of wetlands.	Short account published	P31	Papers and Report	
3.2c	Remote sensing in malaria epidemiology.	Thesis completed	P27	Thesis	
3.2d	Epidemiology drug resistance in Yanomami	Field work completed	P34	Annual Report	
3.3	**Surveillance**				
3.3a	Remote sensing for surveillance, China.	Phase I Field work done	P55	Annual Report	Collab. Funds Continue
3.3b	Surveillance strategy for low level malaria.	Written up and submitted	P35	Paper	Paper accepted
3.3c	Use of 'postcoding' for malaria surveillance	Concept paper done	P37	Concept paper	Time availability
4	**MALARIA POLICY**				
4.1	**Policy**				
4.1a	Mathematical models of falciparum malaria.	Data provided	P58	Annual Report	
4.1b	Historical analysis of malaria policy.	Phase 3 completed	P38	Papers	
4.1c	Collaboration with Consortium	Actively continued		Consortium Report	Consortium still funded

	Activities	Stage reached and Verifiable Indicators	Proj.	Means of Verification	Important Assumptions
4.2	**Concepts and Basic Epidemiology**				
4.2a	Microdistribution of malaria in Bo.	Written up	P33	Draft Paper	
4.2b	Population structure of *A.gambiae* in S Africa.	In progress	P52	Annual Report	
4.2c	Long-term epidemiological consequences of bed nets addressed	Concept Paper			
4.2d	Developing conceptual basis for comparing control approaches	Grant Application Submitted			
5	**CAPACITY BUILDING**				
5.1	**Research Training**				
5.1a	4 EC research fellows' work	Written up		Papers	
5.1b	1 + research students	Complete Trainig		Annual Report	
5.1c	2 new research students	Recruited			Funding available
5.1d	Over 7 research student in training	In Progress			
5.2	**Teaching**				
	GIS in Malaria teaching module	Developed		Annual Report	
5.3	**Programmes Strengthened**				
5.3a	Indian collaboration	Strengthened and Defined		Annual Report	Collaborators remain in post and funding available
5.3b	Programme with Tanzania	Reviewed			
5.3c	Work with Yunnan	Developed			
5.3d	Programme with Zimbabwe	Defined			
5.3e	Programme with The Gambia	Continued			
5.3f	Work with one other national programme	Explored			

The history of treated nets in Tanzania, with emphasis on Programme contributions

The idea of using pyrethroid insecticides on nets originated more or less simultaneously in francophone West Africa and in China, in 1982. Thanks to the presence of Professor Curtis's team, the first experiments in Tanzania took place shortly afterwards, in 1984, at the Amani Medical Research Centre's station in Muheza. This work focused on entomological evaluation, and quickly established the Muheza team as the world's foremost technical reference centre in this field, a distinction it still retains. Several of the techniques developed by this team - including the use of light-traps with untreated nets for mosquito sampling, and verandah trap huts for measuring personal protection at the individual level - have been widely adopted elsewhere.

Meanwhile, the potential of treated nets as a novel approach to malaria control was beginning to attract the attention of public health agencies within Tanzania, most prominently UNICEF. At first, this new technology was seen essentially as an easier alternative to house-spraying, and it was expected that the distribution of nets and insecticide would be organised at the community level, by district health teams and/or by independent local community organisations. In the late 1980's and early 1990's, numerous projects based on this approach took place in Tanzania. This early experience in implementation provided lessons about both nets and insecticide.

The programme's contribution arose from a rather different perception of the potential of this new technology, and of how it could be made available. It did not seem realistic to expect the Tanzanian government, with a total health budget of $4 per person per year, to buy $5 nets for everyone. In the long term, the government was not likely to be the main source of nets, or of insecticides, for most people[1]. On the other hand, nets and various forms of domestic insecticide (coils and sprays) were already commercially available in many places. We therefore began by considering the insecticide as a potential addition to the existing range of commercially available anti-mosquito products.

Several public health projects, including the Bagamoyo bednet project in Tanzania and the Gambian National Impregnated Bednet Programme, had already tried to sell net-treatment through a variety of village-based cost-recovery schemes, with disappointing results. There were fears that this might be due to a lack of basic demand; but our interpretation was that it reflected the way the insecticide had been made available, which was convenient for the providers (e.g. village health workers) but not for the users. This was

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[1] The primary health care system in Tanzania is not yet able to guarantee the "core" service of providing a reliable supply of chloroquine in rural health clinics. This is regrettable, but as long as it remains so, the government should perhaps hesitate before taking on the more difficult task of providing universal coverage of both nets and insecticide through primary health distribution systems. This does not mean that the government should have no role in distribution, only that it cannot do everything for everyone. It must be selective.

later supported by some fascinating social scientific investigations in the Bagamoyo project.

Meanwhile, our own research on mosquito-related behaviour in Dar es Salaam had also revealed a number of interesting points. Careful interviews with residents and monitoring shop sales both indicated that average household expenditure on anti-mosquito products amounted to US$2 or $3 per month. As a proportion of household income, poor people were spending more than the rich. Coils sales from local shops were found to fluctuate week by week in close association with mosquito densities - indicating that coil use is not so much a matter of habit as a deliberate response to an immediate problem. The most startling point, however, was the calculation from these figures that the market in the city as a whole was worth over a million dollars a month. This is much more than the Tanzanian government spends on all forms of vector control in a year.

This work also showed that people who already had nets tended to wash them every few weeks. Moreover, they insisted that washing at intervals of six months or more (as recommended with standard insecticide dosages) would be not only unpleasant but unhygienic. In these circumstances, nets would need to be re-treated more frequently, and it was not clear what dosage of insecticide would be appropriate for this "little and often" pattern of treatment.

Our overall conclusion was that the technology of net impregnation was still at a primitive stage – the equivalent of Edison's first light bulb – and would have to undergo considerable technical evolution before it became suitable as a commercial product.

We anticipated that many practical problems might be solved by a single-dose package of insecticide; this would give net-users greater autonomy by allowing them to treat their own nets at home. Our concept was a complete dip-it-yourself kit, with instructions, that could be sold in small shops alongside coils and sprays. Such kits were beginning to be made available, mostly by small specialist companies, for the tourist market in developed countries. The idea that similar products might be commercially viable in the domestic market in tropical countries was, however, regarded with considerable scepticism. The chemical manufacturers obviously thought that treated net projects and programmes would be their primary market.

We therefore set about the research needed to develop such a home-dipping kit. Using a combination of technical and social scientific methods, we developed a local production facility for sachets of insecticide, and devised and tested a set of instructions. At the same time, we also tried another way of making insecticide commercially available: offering a dip-your-net service, from a kiosk in Dar es Salaam. Business was poor, and whilst it might have been better if we had advertised, the experience as a whole suggested that this approach to selling insecticide was too specialised to be viable as a shop's sole business. The results with the "dip-it-yourself" kit were much more encouraging: we showed that it could be used safely and effectively by ordinary people without training or supervision, and that it was very popular.

Our plans for small-scale marketing trials of this kit were overtaken by the appearance of two much larger social marketing projects[2], both of which were keen to adopt our kit as one of the main channels for distributing insecticide. We readily agreed to this, and contributed to the planning of the larger of the two projects[3]. (In fact, we also contributed our field researcher, Dr Janee Miller, who was recruited by this project as its manager). The collaboration is continuing. There are many outstanding questions about how the dip-it-yourself kit will work in practice, and some of these will be dealt with in the monitoring and evaluation of this project. We hope that the viability of the kit as an independent commercial product will be demonstrated, at least in Dar es Salaam where net use is common.

While these developments were taking place with the insecticide, what was happening about nets in Tanzania? The situation has changed dramatically over the last few years, and interestingly, most of these changes have occurred without the direct involvement of public health agencies.

Fifteen years ago, nets were extremely rare in rural Tanzania - in villages around Muheza, for example, less than 5% of families had a net, and most of these were in very poor condition. Even in towns, nets were not a common sight. They were, however, available in some fabric shops, and such shops were present in most medium-sized towns. The price was about $8 to $15, depending on size and quality. A net was generally perceived as something that was desirable but difficult for most people to afford.

Against this background, how should public health agencies go about the task of promoting net ownership? The strategy actually adopted in many Tanzanian projects has been to buy nets on the international market, distribute them through project channels, and sell them locally at subsidised prices. (In fact, this has been the model adopted by the great majority of projects outside of China and Vietnam.)

In such projects, the selling of subsidised nets is often regarded as an end in itself, and success in this activity is expected to guarantee sustainability. In some cases this may be so, but this depends on the sustainability of the subsidy itself, which in turn usually depends on the donors. In some cases, donors have indeed been willing to provide long-term support to such projects – the Healthnet International operations with refugees in Pakistan appears to be one example of this. Some have been structured such that the donor pays for the fixed recurrent costs of maintaining the delivery system, while the

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[2] One of these has already been operating for a year; it covers the Kilombero Valley, and is based in the Ifakara Centre of the National Institute of Medical Research. The other is just starting up, and plans to work in several locations including Dar es Salaam; it is being funded by DFID East Africa, and is conducted by Population Services International (PSI), who are better known in Tanzania for the social marketing of condoms.

[3] These developments in the dip-it-yourself approach have also attracted interest outside Tanzania. We have been approached by several projects elsewhere in Africa, and at least three manufacturers are currently developing formulations and products suitable for the domestic market.

revenue from net sales goes into a "revolving fund"; this continues to "revolve" as long as every net sold makes enough money to buy another net. Revolving funds are notoriously difficult to manage and maintain, but one successful example has been running for several years in the Turiani area, Morogoro Region, Tanzania. Other projects have been built on an initial injection of capital, in the form of nets paid for by the donor, and the sales revenue from these nets pays for the running costs; when the capital runs out, a fresh injection of funds (or nets) is required. The net-distribution activities of the Bagamoyo Bednet Project is one example of this approach; another is the Keonjhar project in Orissa, India.

From the donor's point of view, one advantage of this "sustainable subsidy" approach is that it allows geographical targeting; another is that it allows alternative distribution channels to be compared in clear terms: dollars per net delivered. The marginal costs of distribution can be compared with those of commercial systems, which add only $2 to $4 dollars to the factory price of the net, at least in places where nets are common, like The Gambia and urban Tanzania. Another informative comparison is with the price of the net itself. After all, it is always possible to spend all the project money on nets, and then simply to leave the warehouse door open. This may seem absurd, but it is surely not as absurd as spending more money for the same outcome - if the simple aim is to maximise the short-term rate at which nets are "pumped out". It is likely, of course, likely that a large proportion would be gathered (with increasing success) by commercial traders, who would then sell them on. This is not a problem in principle: the donor may be satisfied that its contribution has provided someone somewhere in Africa with a net[4].

It does, however, have implications for efforts at targeting. If local people can easily obtain nets for free, traders will not be able to obtain good prices locally. In fact the degree to which the local street-price of a net has been reduced can be seen as a measure of success in improving access for the poor. Traders will presumably tend to ship nets out of the area and sell them on elsewhere, in places where higher prices can still be obtained. The more they do so, nets will become scarcer locally, and prices will again rise. This process will continue until the difference between the local street-price and that elsewhere is so small that moving the nets is no longer worthwhile. Thus, we should not expect it to be easy to reduce effective prices in one area in isolation, or for one group of people and not another. This again might not be a problem, if the donor has big pockets. At first, no doubt, the nets would be sold on at high prices to relatively rich people, but eventually this group would be saturated; the price would then go down to a level that slightly poorer people can afford. But this can only happen on the very large scale, requiring a very large financial commitment.

These arguments apply not just to the idea of making nets available in large numbers for free (i.e. with 100% subsidy); they are equally relevant to a system of partial subsidies.

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[4] There is every indication that almost all the nets would find their way to a bed, and would be used. This is certainly so in Tanzania, where instances of nets being made into curtains or clothes or fishing nets are conspicuous exceptions. Other parts of Africa where mosquitoes are common appear to be much the same.

Experience in Tanzania clearly shows how hard it is to flood a local market: a Japanese project released 180,000 nets in Dar es Salaam and Tanga, selling them in any quantity to anyone with the money. As expected, many were bought by traders, and were a conspicuous sight on the city streets, but the prices at which they were sold were not noticeably lower than before. In other words, the nets did not go to waste, but the money invested in the subsidy did not reach the users; rather it became a windfall profit for the traders.

In practice, subsidies are not normally unlimited. Donors are not yet willing to commit themselves to buying the millions of nets it would take to flood the market (and hence to reduce effective prices) in a country or even an economic region. It therefore seems that selling subsidised nets should not be an end in itself. Ultimately, most people will have to buy nets at unsubsidised prices, presumably from commercial sources. This is not unrealistic: the situation in The Gambia and Tanzania indicates that when the market is healthy, commercial prices are reasonable and many people can afford to buy. It therefore seems that the government's role is two-fold: (a) to try to bring about this situation, and (b) to try to provide for those people who are still unable to afford commercial prices.

Selling subsidised nets can be used for both these ends, but the measure of success is not then simply the number of nets sold. Success in promoting the commercial market must be measured not as the number of project nets sold, but rather in terms of the increase in sales of non-project nets. This may not be easy, since the free availability of subsidised nets will produce a local and temporary depression in the sale of nets from commercial sources, and the increase that is hoped for will only occur during the project outside the project area, and within the project area it will occur only later, after the subsidised nets are no longer available. Of course, selling subsidised nets is not the only way in which governments can promote commercial sales. It may be that the best strategy is make a kind of compact with local suppliers: the government pays for intensive promotion, to ensure that traders who invest in nets will find customers, while the traders' role is to ensure that nets are available for people who want to buy.

If the aim of the subsidy is, instead, to promote equity, then every effort must be made to ensure that the subsidised nets reach, and stay with, their intended recipients. The problem, as we have seen, is to find a way of offering an artificially low price for one group of people, while maintaining a higher price for the rest. It is not feasible to do this by means of a means test, but it might be possible to target pregnant mothers: prospective buyers can easily pretend to be poorer than they actually are, but it is not so easy to pretend to be pregnant.

We have incorporated these ideas into the design of the large DFID-supported social marketing project that is now starting in Tanzania, and plan to work with AFRO to develop them into more a more general set of programmatic strategies applicable elsewhere.

Urban Surat Malaria Control and Research Project

Introduction

The overall aim of the urban Surat malaria control and research project is to reduce malaria incidence, morbidity and mortality in Surat and to help develop strategies which can subsequently be applied elsewhere in India. The first step was taken in June 1996 with the establishment of a study to develop an algorithmic approach to diagnose clinical malaria. During the first half of 1997 approval and funding was granted by DIFID for a further three projects to help complete the urban programme. These were: (i) a study of the relationship between malaria and migrants in the city, (ii) a project investigating the role and quality of care provided by the public and private health care sectors in the city, and (iii) an insecticide treated bednet acceptability study. All three projects were to be managed by the Department of Preventive and Social Medicine (PSM), Government Medical College, Gujarat who were already involved in running the clinical diagnosis of malaria study. The individual objectives and proposed outputs of each of these projects are:

Clinical Diagnosis Study:

- To assess the predictive value of different signs and symptoms to diagnose clinical malaria in a passive case detection setting.
- To identify appropriate constellation of signs and symptoms of malaria that could be used to help different grades of health workers in the diagnosis of episodes of malaria.

Migrant Study:

- To investigate the association between the pattern of migration and the prevalence of asymptomatic and symptomatic parasitaemia, parasite density and anaemia.
- To explore the association between place of origin and beliefs and behaviours (including preventive and treatment seeking behaviours) concerning malaria.
- To develop a data base on the epidemiology of malaria in migrants to be used for planning malaria control strategies in Surat city (e.g., setting up a system to identify and follow up high risk groups of migrants).
- To develop health education materials appropriate to the various migrant groups and to identify the best channels of communication for the delivery of such materials.

The Public/Private Mix:

- To examine the relative roles of public and private for profit providers and to evaluate their provision of malaria prevention and care services in Surat.
- To develop, implement and evaluate pilot intervention strategies for enhancing the quality of appropriate public and private sector management of malaria.

Bednet Acceptability Study:

- To investigate current attitudes towards and use of mosquito nets.
- To identify NGOs/Co-operatives to undertake the social marketing of nets and net treatment and retreatment.
- To evaluate the effect of the intervention on net knowledge and net use and to assess the sustainability of the method for future use.

The projects are closely linked in terms of data requirements and for that reason, and in order to utilise the human resources and logistics efficiently, it was decided that, where possible, the studies should run concurrently in selected study areas. There was also a clear need for co-operation and understanding between the research teams involved in the various projects and consequently a workshop was organised in late August 1997 to integrate and launch the projects. The workshop was sponsered by DIFID, orgasnised by PSM and attended by consultants from the London School of Hygiene and Tropical Medicine (LSHTM), co-investigators of the research projects from PSM, representatives of the Surat Municipal Corporation (SMC), National experts from the Indian Malaria Research Council (MRC), officers from the British Council Delhi (BCD) and the Surat Malaria Control and Research Project Co-ordination Office (MCRP) and representatives of various Private Practitioner Associations such as the Indian Medical Association (IMA), the Physician's Association, the General Practitioners Association (GPA), the Paediatricians Association and the Pathology Association. The workshop deliberations were very useful in helping to streamline and integrate the proposed activities, and more significantly the workshop contributed to the involvment of researchers, programme managers, key stakeholders and policy makers in the process from the outset of the research.

Methods

Selection of study sites: The team from PSM have been working for several years in three areas of Surat city, namely; Rasulabad (a planned slum), Amliran (a middle class area in the old walled city) and Dabholi (a peri-urban site). Detailed demographic data on the households within each of these areas has been collected and it was decided that these areas should be selected as sites for the urban study. However, selection criteria for the sites of the migrant study stipulated that one site should have a majority (>25%) of households from Orrisa, one should have a majority of migrants from South Gujarat and one should have a minority (< 5%) of households from either of these two areas. Only one of the criteria for the migrant worker study was covered by the three sites (namely Rasulabad, a slum with less than 5% of the population from either South Gujarat of Orissa) and therefore two additional study sites were selected. These were; Siddharth Nagar (a slum with a predominantely Oriya population) and Milan Nagar (a slum with a predominantely South Gujarati population). The provider study is being undertaken in all five sites and a random selection of 10% of providers from elsewhere in the city will also be included in the sample. Due to logistical constraints it was considered impossible to undertake the bednet project in all five areas and so two slums (Rasulabad and Siddarth Nagar) and the peri-urban area (Dabholi) were chosen as sites for the study. A breakdown of which studies are being undertaken in each study area are shown in Figure1.

The methods being employed to collect the data for the urban project are represented diagramatically in Figure 2.

Phase 1.
The first phase of data collection involved a mass blood survey to determine the prevalence of malaria in the study areas and a baseline household survey (questionnaire) to determine the composition and socio-economic characteristics of the households and their practices regarding protection against mosquitoes. At the same time, the fieldworkers from PSM carried out a mapping exercise recording the location and the details of all treatment providers (including allopaths, ayerveds, pharmacists and unqualified providers) within the study areas.

Following the surveys active case detection (ACD) was initiated in all five study areas. The SMC workers, accompanied by PSM fieldworkers visit each household in their area every two weeks to monitor fever cases and to take blood slides from those who complain of a fever at the time of the vist or during the previous week. Where fever is reported a note is also taken of the preventive and treatment measures that have been undertaken during the previous two weeks and any movements away from Surat are recorded. In addition to ACD, the PSM fieldworkers are also undertaking fortnightly monitoring of the movement of people into and out of households in those areas where the migrant study is being undertaken.

In addition, during the first phase of data collection interviews were held with key stakeholders in the provider study to ascertain their views on; their activities, their role in malaria treatment and prevention, their views on the important issues in relation to malaria control and treatment and their relationship to the other key stakeholders. At the same time the social science research team (one social scientist per study area) spent two months developing contacts and becoming familiar with the communities that they would be working in.

Phase 2.

In January 1998 the social scientists on the PSM team started the process of detailed qualitative data collection. During their time of community familiarisation the social scientists had identified the 'natural groupings' within each of the study areas and focus group discussions were carried out with representatives of each of these groups. The topics under discussion included; views on the most important health problems of the community both in Surat and in their native place, beliefs about the causes and prevention of febrile illness and malaria, details of treatment seeking behaviour for febrile illness and malaria, views on why certain providers are chosen and what makes a good doctor, what were believed to be the most reliable and trusted sources of information on health issues, and what messages people had heard regarding malaria prevention and control.

On completion of the focus group discussions the social scientists undertook a series of structured indepth interviews with people in the community who owned nets and an equal number who didn't own nets. The net owners were randomly selected from the baseline household survey data (every tenth net owning household was selected for interview) and the non-net owners were selected by interviewing their neighbours. If the neighbour also owned a net then the interviewer moved onto the next house until they found a household that didn't have nets. The interviews concentrated on issues such as; views on mosquito nuisance, methods to prevent the nuisance, whose responsibility it is for mosquito control, knowledge and behaviours about malaria, and sources of information about health issues. For those that owned nets the interviewers also asked about the nets; how much it cost, how long it had been used, at what times of year, who made the decision to buy it etc.. For those that didn't own a net the questions concerned their knowledge about and attitudes towards nets and their reasons for not owning one.

During phase 2 in the provider study further meetings were held with key stakeholders and a stakeholder questionnaire was piloted and administered to key organisations in Surat. At the same time a detailed structured questionnaire and facility checklist was devised and piloted ready for administration to all of the providers within the study areas and to 10% of providers from elsewhere in the city.

Throughout this phase the ACD and monitoring of migrant movement was on-going.

Phase 3.
We are currently at the end of phase 2 of data collection and just starting to move into phase three. During this phase the data collected during the focus group discussions and indepth interviews is being used to help develop; (i) an appropriate information and education campaign about the prevention and treatment of malaria and (ii) a campaign for the promotion of insecticide treated bednets (ITNs). The data is also being used to identify the most effective channels of communication for the dissemination of the material.

The bednets have been purchased untreated by the project and are being treated with insecticide by the SMC workers together with NGOs and community groups from Rasulabad, Dabholi and Siddarthnagar who have volunteered to undertake the task. The treated nets will be sold by the NGOs and/or community groups in each area and the purchasers will be informed that they can have their net retreated for free in 6 months time.

Active case detection and the monitoring of migrant movement are continuing and it is planned that these activities should run until October 1999.

In the provider study, once the questionnaires with the providers have been completed the social scientists will conduct exit interviews with treatment seekers (e.g., at clinics, pharmacies etc.) and will undertake observations of provider and patient behaviour with those providers who agree to take part in the study. The social scientists will also undertake case studies of fever patients, i.e., a fever patient will be identified by exit interview and the participant will be asked if the interviewer could visit them at home in three then seven then fourteen days time to see how the fever is progressing and to see what other treatments are being sought or undertaken. The exit interviews, observations and case studies will take place among the range of providers (e.g., non-qualified providers, pharmacists, homeopaths, allopaths etc.) that have been identified in the study areas. These methods of data collection can be problematic but they are worth attempting as they can be a very valuable source of information and can reveal details that are impossible to obtain from any other source. Obviously the presence of an observer, and/or the knowledge of follow up interviews will have an impact on behaviour but repetition and triangulation of the data should help to moderate observer influence and reduce the impact of bias.

The key stakeholders in the provider study are preparing a public position paper to be disseminated among the different stakeholders. Expert subcommittees are being set up to explore and make recommendations on key technical issues for consideration at a workshop on proposed interventions. The data collected by the social scientists on provider and community beliefs and behaviours will also contribute to the design and choice of interventions. The interventions that are agreed at the workshop will be piloted in Surat during the latter half of 1998.

Phase 4.
The interventions (information and education campaigns, the promotion and distribution of mosquito nets and net treatment and the provider interventions) will run for twelve to eighteen months. After this time there will a further round of focus group discussions, indepth

interviews, exit interviews, case studies, treatment observations and an end of project survey to assess the outcomes of the interventions. An outline activity plan from April 1998 to the end of the project in March 2000 is shown in Figure 3.

Results

Between June 1997 and January 1998, 1093 children (<15 years) and 1288 adults (15+years) have been enrolled in the clinical diagnosis study. An interim analysis of the validity of several clinical opinion based algorithms (Figure 4,5 &6) to diagnose malaria were conducted using the blood slide positive for malaria parasite cases as true cases of malaria. The results of this analysis shown in Tables 1&2. An ideal algorithm should have sensitivity and specificity close to 100%. However algorithms with sensitivity and specificity >90% would be useful as a screening tool. None of the clinical opinion based algorithms had such levels of sensitivity and specificity. Nevertheless, algorithm2 which had a sensitivity and specificity >60% may be useful as a screening tool to decide on the type of antimalarial drug in situations where medical practitioners prefer to prescribe second line antimalarial drugs for all cases of febrile illness. We intend to derive diagnostic algorithms from these data using appropriate statistical methods and to test their use as a screeing tool.

To date a total of 28 focus group discussions have been undertaken: 10 in Rasulabad, 10 in Siddarthnagar and 8 in Dabholi. A further twelve group discussions remain to be held, 6 in Milan Nagar and 6 in Amliran. We are in the process of analysing the data from these discussions but it is already obvious that people in all three areas consider malaria to be one of their major health problems. People of different linguistic (migrant) groups used a variety of terms to describe fever e.g., Tao in Gujarati, Joro in Oriya and Taap in Marathi. Malaria was described by using the suffix 'malaria' infront of the local name for fever, e.g., Oriya speakers identify malaria as 'malaria Joro' and Gujarati speakers call malaria 'malaria ho tao'. All of the groups also identified two types of malaria; simple (Sado) and complicated (Jehri or Magajnotoa) malaria, with the complicated form being identified by the additional symptoms of vomiting and paralysis. While mosquitoes are associated with malaria transmission they are thought to be only one of several possible causes of the disease.

The data from the baseline survey is also in the process of being analysed but the data on current net ownership is available. In Rasulabad 20% of household own at least one net, in Dabholi 7% of household own at least one net and in Siddarthnagar 8% of households currently own at least one net. The current market price for an untreated net is Rs200 (approx. £3.00) and preliminary information from the in-depth interviews suggests that people in these areas would be willing to buy a net if it cost Rs100. This will be the target price for the treated project nets.

In the provider study recommendations for interventions have been developed and these will be considered at the stakeholder workshop. The suggested interventions include: (1) inproving access to affordable, high quality lab facilities for malaria diagnosis; (2) preparation of treatment guidelines; (3) development of provider accreditation systems; (4) provider training; (5) community education strategies; (6) data recording and reporting systems.

Conclusion

The project has already contributed to the development of a methodology for studying urban malaria in India, particularily in the use of stakeholder analysis. it has also produced interesting results which have been fed back into the further development of the study and into the planning of the control of malaria in Surat.

Table 1 : Validity of selected diagnostic algorithms in children

Algorithm	True malaria diagnosed correctly n=71	True non-malaria diagnosed correctly n=1021	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Doctors Clinical diagnosis	65	206	92	20	14	97
Algorithm-1 (Figure2)	71	41	100	4	7	100
Algorithm-2 (Figure3)	43	627	61	61	10	96
Algorithm-3 (Figure4)	61	349	86	34	8	97
Algorithm-4[$]	38	689	54	67	10	95
Algorithm-5[@]	54	385	76	38	8	96

$ H/o no running nose was added in algorithm-2 to diagnose malaria

@ H/o headache was added to algorithm-4 to diagnose malaria

Table 2 : Validity of selected diagnostic algorithms in adults

Algorithm	True malaria diagnosed correctly n=165	True non-malaria diagnosed correctly n=1118	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Doctors Clinical diagnosis	162	78	98	7	13	96
Algorithm-1 (Figure2)	158	64	96	6	13	90
Algorithm-2 (Figure3)	118	441	72	39	15	90
Algorithm-3 (Figure4)	150	181	91	16	14	92
Algorithm-4[$]	115	480	70	43	15	91
Algorithm-5[@]	148	232	90	21	14	93

$ H/o no running nose was added in algorithm-2 to diagnose malaria

@ H/o headache was added to algorithm-4 to diagnose malaria

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Figure 1. URBAN SURAT MALARIA CONTROL PROJECT

DABHOLI

Migrant
Private Provider
Bednet

RASULABAD

Migrant
Private Provider
Bednet

SIDDHARTHNAGAR

Migrant
Private Provider
Bednet

AMLIRAN

Private Provider
Bednet

MILAN NAGAR

Migrant
Private Provider

SURAT OTHER

Private Provider

Figure 2. URBAN SURAT MALARIA CONTROL AND RESEARCH PROJECT
Methods for Collection of Data on Community Beliefs & Behaviours *(CB)* and Provider Beliefs and Behaviours *(PB)*
 # = data for provider study; ! = data for migrant study; + = data for bednet study

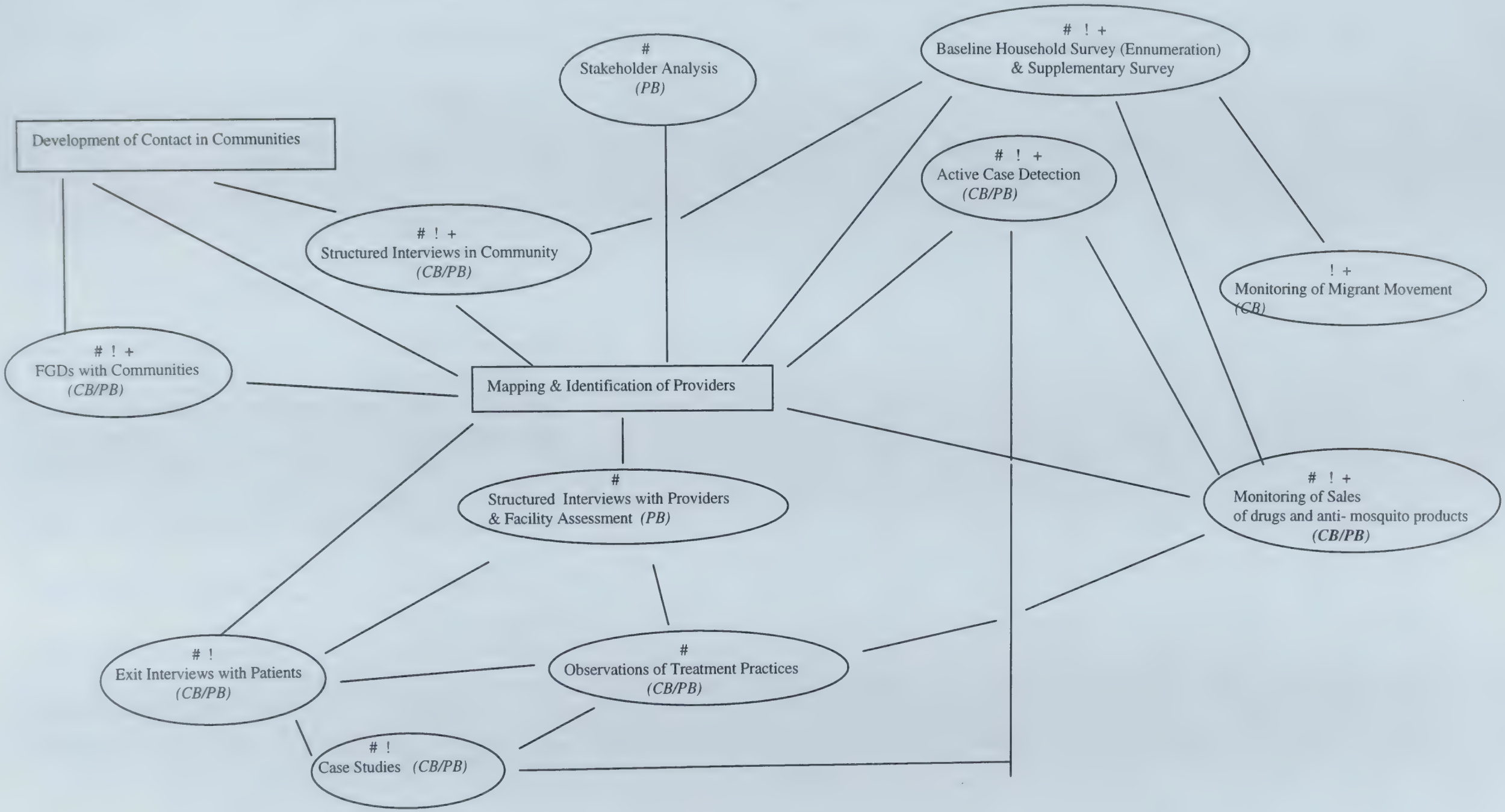


Figure 3. Urban Surat Malaria Projects: Revised Action Plan (April 1998)

		1998								
ACTIVITY	**PERSONNEL**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Active Case Detection	FW/SRW	x	x	x	x	x	x	x	x	x
Monitoring of drug and anti-mosquito product sales	FW	x	x	x	x	x	x	x	x	x
Structured Interviews	SRS	x	x	x						
IEC and bednet promotion	SRW/NGOs			x	x	x	x	x	x	
Bednet distribution	NGO/community organisation			x	x	x	x	x	x	x
Facility assessment and provider questionnaire	SRO with MO SRO with SRS			x	x					
Exit interviews	SRS					x	x	x	x	x
Case studies and observations	MO and SRS					x	x	x	x	x
Stakeholder workshop	PSM/DIFID/LSH TM/Stakeholders					?	?			
Provider interventions	Stakeholders							x	x	x
Interviews/FGDs re: net purchase	SRS								x	x

Figure 3. Urban Surat Malaria Projects: Revised Action Plan (continued)

		1999												2000		
Activity	Personnel	jan	feb	mar	apr	may	june	jul	aug	sept	oct	nov	dec	jan	feb	mar
Active Case Detection	FW/SRW	x	x	x	x	x	x	x	x	x	x					
Monitoring of drug and anti mosquito product sales	FW	x	x	x	x	x	x	x	x	x	x					
Bednet promotion	NGOs		x	x	x	x	x	x	x	x						
Bednet Distribution	NGOs	x	x	x	x	x	x	x	x	x	x					
Bednet Retreatment	SMC/ NGO		x	x	x	x	x	x	x							
Provider Interventions	Stake -holders	x	x	x	x	x	x	x	x	x	x					
Exit interviews	SRS	x	x	x	x	x	x						x	x	x	
Case studies and observations	SRS/MO	x	x	x	x	x	x						x	x	x	
Interviews/FGDs re: net purchase	SRS	x	x									x	x	x		
End of project survey	FW/SRW													x	x	x

Figure 4: Algorithm1

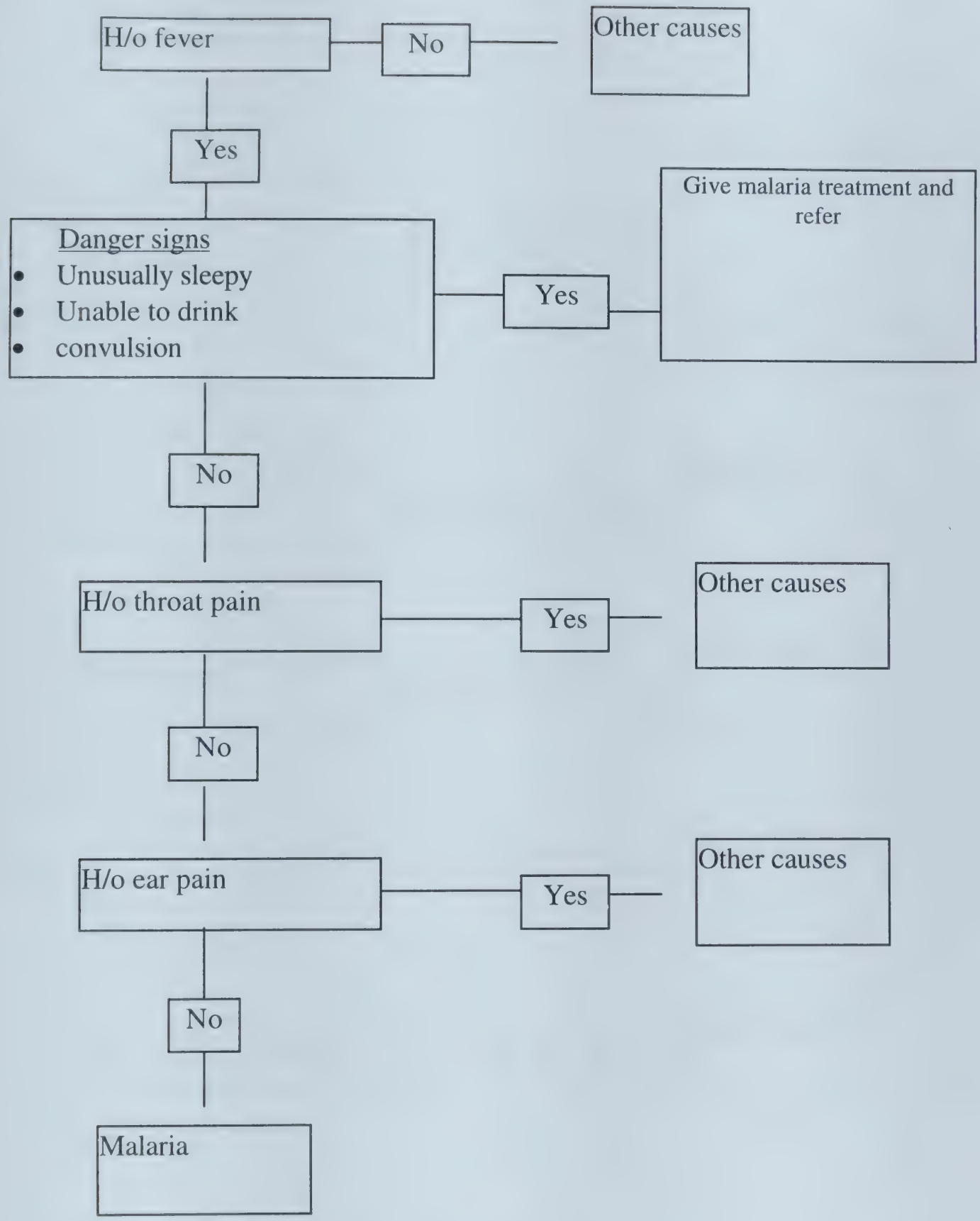


Figure 5: Algorithm2

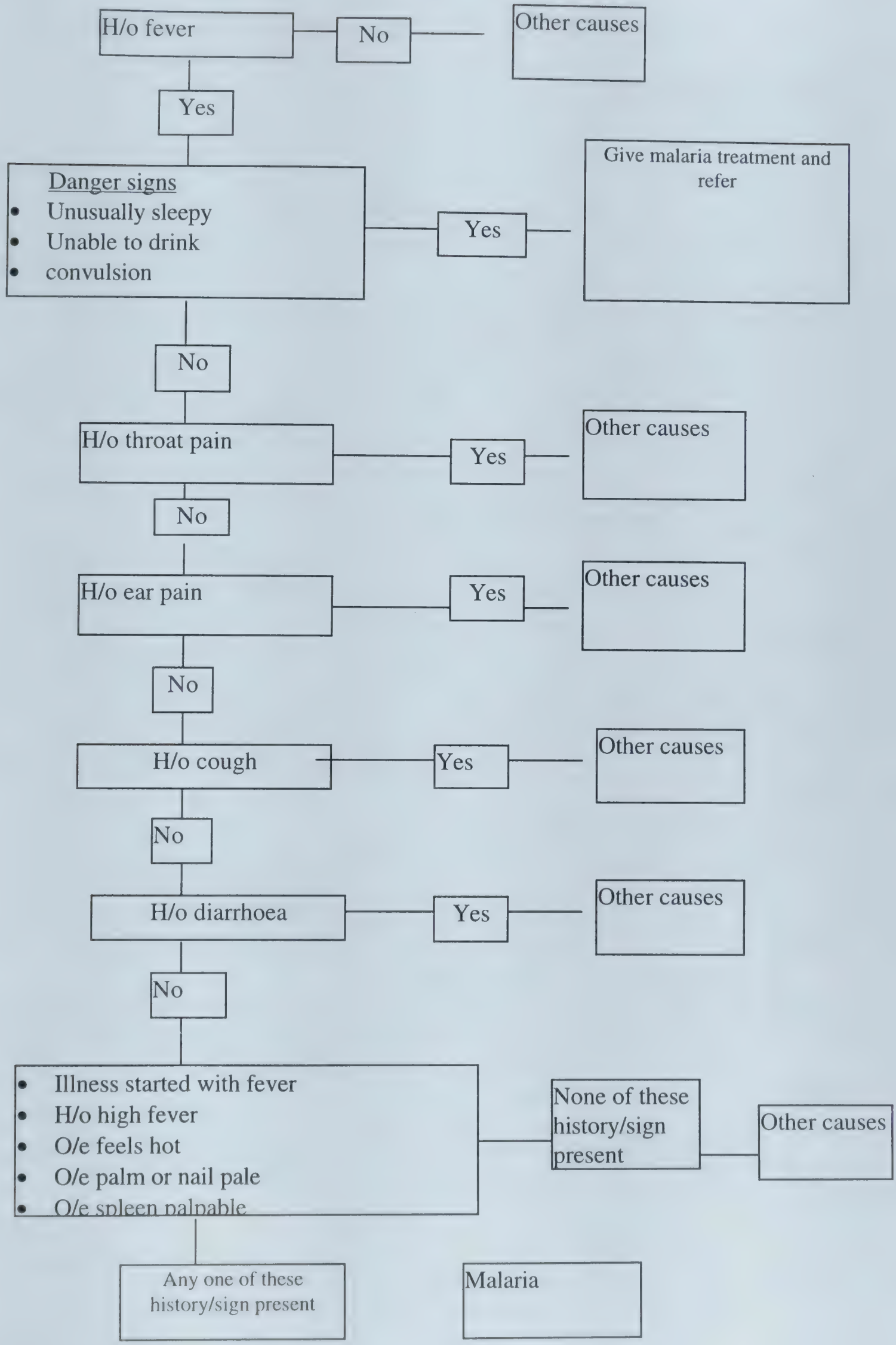
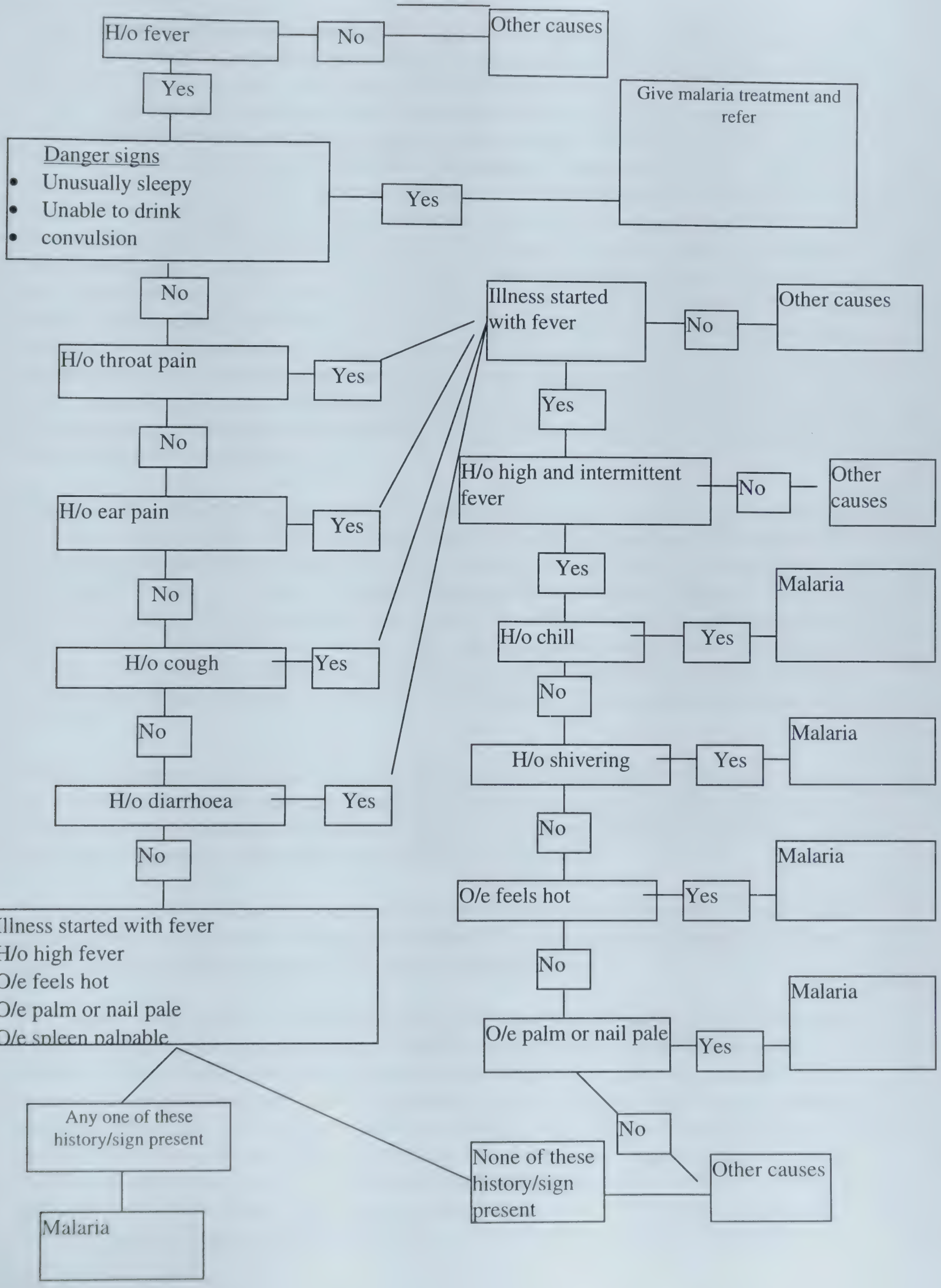


Figure 6: Algorithm3



Background to Surat

The Surat project arose from a request by the Head of HPD to the TDC Programme head in 1988 to seek to develop large field trials at national level and supported by bilateral (desk) funding from ODA (as it then was). About this time two projects were put to the Programme head for review: each had been put to a country desk through the national governments in India and Bangladesh respectively. They were remarkably similar to each other and comprised large field trials of residual insecticides, with most of the funds going for insecticide purchase. It was clear that this was not a good project approach, but because each had been approved by the country concerned it seemed appropriate to start from these projects and recommend modifications as a way of getting to useful desk-funded research. This was duly done in a series of reviews and revisions undertaken with the national malaria authorities (who had been largely by-passed over the original proposals). By 1990 relatively useful proposals were formulated, with broader country-appropriate objectives but with limitations due to their origins. Because insecticides remained involved, and consequent on a vicious campaign between rival manufacturers, the Bangladesh proposal became unimplementable, but that in India grew into a useful and viable 5-arm rural trial wanted by the NMEP as a guide to policy. Revisions to the social aspects of the project requested and redrafted by ODA delayed approval until 1995 when the project began in Surat district of Gujarat State.

By this time the cycles of malaria had led to a much lower incidence in the study area than had been the case when it was designed. This had implications for the trial which had to be reduced to three arms to conserve statistical power and required an ad hoc surveillance system as the existing routine one was shown to be clearly inadequate to cope with the incidence levels. The redesign strengthened the comparative assessment of ITMN. A smaller undesigned urban component had been left in the overall plan, and was subsequently expanded as a basis for both building local capacity and tackling the major but relatively neglected problem of urban malaria in South Asia, which is the one part of the world where there is a truly urban vector, *Anopheles stephensi*.

The very considerable difficulties in getting the Surat project running have made great demands on the Programme and all the staff involved in the field and upon our collaborators, and one output from the programme will be a case study of this complex project from which we feel much can be learned of relevance to bilateral policy on research.

The project is now being highly productive in terms of new knowledge, contributions to Indian national policy, and capacity building at many levels. The outputs now becoming available will have widespread implications for policy, operations and research.

At an earlier stage, a key event was the opening workshop which involved not only local and Programme staff but also the directors of NMEP and the Malaria Research Centre (MRC) of ICMR. This produced a substantial national research agenda, which was to be fed into the operational research component of the large malaria programme to be funded by complementary components from the World Bank and ODA (now DFID). Both the Programme staff and the UK Malaria Consortium put much effort into assisting this process and it appeared likely that ODA would fund operational research, to which the Programme could then have made a substantial input, and to which the above Surat workshop made a good start. Unfortunately, for reasons in ODA beyond our influence, ODA progressively withdrew from the WB/ODA plan, so that much

effort was wasted.

The work at Surat therefore now has, in addition to its training and malaria control activities, several research aims:-

To measure the efficacy of ITMN and residual insecticide house spraying in control of malaria spread by *An. Culicifacis*.

To gain a full understanding of urban malaria in India by multidisciplinary studies.

To build operational research, and higher teaching capacity in Surat, Gujarat and more widely.

To develop predictive models for malaria in Gujarat based upon remote sensing and to relate this to climate and land use.

Related aspects of operational research, especially on malaria surveillance.

While the prospect of contributing in a major way to policy in India and the need to make the complex Surat project effective led to very strong inputs of Programme time and effort to Surat, the limited potential that results from the above ODA policy decisions means that unless there are further changes, while we shall continue to move the Surat project forwards energetically, in collaboration with all our partners in India, and with the British Council who deal with field management, more emphasis will now also be given to African work and we intend to transfer the methodology and team approach developed in urban Surat to the problems of urban malaria in Africa which have hitherto been relatively neglected.

Highland malaria

Recently much speculation has centred on the issue of highland malaria, particularly in Africa. Highlands have traditionally been regarded as areas of little or no malaria transmission, primarily because of the negative impacts of low temperatures on parasite sporogony and vector development. However, this picture appears to be changing, with recent evidence indicating an increase in the number of epidemics in highland areas, as well as increasing stability of transmission in highland fringes. Various mechanisms for this apparent change in epidemiology have been put forward, of which those implicating climatic and ecological change (and particularly changes in land use patterns) have been most prominent. Unfortunately the lack of reliable malaria data for most highland areas has made analysis of these issues difficult, and in situations where malaria data are available, it is not always possible to separate individual risk factors (*e.g.* land use change) from confounding variables such as variable drug supplies and residual spray coverages.

Epidemic malaria in highland areas represents a significant public health problem. Historically, low risk of infection in highland areas has created little immunity in local populations, resulting in relatively high case mortality in adults and children during epidemics. At the same time, national malaria control programmes have been poorly equipped in terms of identifying and responding to epidemics. There is, therefore, a dual need for increased scientific understanding of the epidemiology of highland malaria, as well as greater capacity in epidemic surveillance and response. This issue was raised at the TDR/WHO's 'Task Force Meeting on Highland Malaria in Africa', held in Addis Ababa in May 1996, at which a general framework for future research was proposed.

The project 'the Epidemiology of Highland Malaria in Africa' that came from the Addis Ababa meeting is being carried out jointly by LSHTM and the Medical Research Council in South Africa, and is part of the pan-African collaboration 'Mapping Malaria Risk in Africa' (MARA). The project addresses both academic and operational issues in highland malaria, with the principal aim being to develop a collaborative network of sentinel sites to monitor prospectively malaria transmission (and by implication, epidemics) and associated risk factors in highlands. Work is currently focussed on the following activities:

* **Development of products to stratify risk of malaria in highland areas**; using continental datasets for climate and altitude to produce GIS models of malaria risk for highland areas. Large format maps have been produced for all highland countries in Africa and have been circulated to control programmes.

* **Validation of spatial risk models**. Work over the past six months has focussed on collating data to verify the spatial distribution models described above. This has involved a series of country visits and coordination with local research institutions and control programmes to obtain as much relevant data as possible. To date over 300 reports have been collated for eight countries, which together have yielded information on parasite rates for over 900 localities. In certain countries, and most notably Kenya, the project is providing funds for control programmes to computerise historical data, and to improve capacity in data input and analysis.

* **Development of protocols for surveillance**. Experience in other sectors has shown that sustainable, effective early warning systems are only feasible if developed with the needs and constraints of the end user (in this case malaria control programmes) in mind. Under the highland malaria project a workshop including local scientists and control programme managers will be used to design sustainable surveillance systems that allow for appropriate capacity building in areas of GIS and epidemic early warning. At present it is anticipated that control programmes from Kenya, Tanzania and Uganda will be involved in this process. The proposed sentinel sites will be managed by local scientists and institutions, with some coordination (in terms of the network) and technical input assistance from outside. This assistance will involve training in GIS (at both LSHTM and the SAMRC) and appropriate analytical techniques, as well as provision of appropriate computer hardware and software.

* **Surveillance by Remote Sensing for Difficult Terrain**. Most of China's malaria is now concentrated in the hilly border province of Yunnan, and the landstanding case detection system is deteriorating. GIS analysis of existing maps has been used to generate a model explaining some of the malaria variation, and current fieldwork aims to provide a reliable standard for its further development. The aim is to produce a surveillance method for malaria that is usable in inaccessible countryside; it meets a felt need of the Provincial Malaria Service and is part of a wider collaboration.

ANNEX 6

Expenditure 1997-98

Salaries	246715.32
Other Recurrent	35361.04
Equipment	3637.64
Administration	114286.00
	400000.00

Budget Estimate 1998-99

Salaries	255714.00
Other Recurrent	30000.00
Equipment	0
Administration	114286.00
	400000.00

DFID Malaria Programme

Inventory April 1997 - March 1998

Model Inventory Sheet

Annex 1

Item	Make & Model	Serial No*	Date Rec'd	Purchase Price	Location	Disposal		
						To	Date	Authorised
Desk Top PC	Viglen Genie AJx P5/166	1095696	Nov. 1996 (Invoice not	£1477.64 received until	DAVID BRADLEY April 1997)			
Desk Top PC	Viglen Genie AJx P5/150	1095798	Nov. 1996 (Invoice not	£1355.14 received until	NUAHN MARBIAH May 1997)			
Desk Top PC	Viglen Genie AJx P5/150	1095796	Nov. 1996 (Invoice not	£1355.14 received until	JON COX April 1997)			
Fax Machine	Panafax UF-550	01970200184	May 1997	£1051.63	HELEN PRIESTLEY + DAVID BRADLEY			

3 PC's eared on Inventory 96-1997). oices not eived until ancial yr 97-98.

* This column must always be completed. The number may be the manufacturer's serial number or one generated by the inventory holder's own sequential numbering system. In the case of the latter, the number must be clearly marked on the item itself.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE

RESEARCH PROJECT EXPENDITURE AND CLAIM RF7

To: Department for International Development
Health and Population Division
94 Victoria Street
London
SW1E 5JL

Date: 7/5/98

Project title: Malaria

Investigator: Prof D. Bradley

DFID ref: Programme

Period: 1/12/97 - 31/3/98

LSHTM ref: EPTHHC84

Budget heading	Budget 1997/98 A	Previous spend this year B	Expenditure for this period C	Total spend this year (B+C) D	Balance of budget remaining (A-D)*
Salaries	242344.00	160840.81	85874.51	246715.32	4371.32
Other recurrent	43370.00	28163.01	7198.03	35361.04	}
Equipment		3637.64		3637.64	} (4371.32)
Administration	114286.00	77057.58	37229.42	114286.00	—
Contingencies					
Totals	400,000.00	269688.04	130301.96	400,000.00	—

Balance at the beginning of this period * (130301.96)
less
Expenditure for this period 130301.96
equals
Balance at the end of this period * —
add
Advance due for next period 133,333.00
equals
Total advance now requested 133,333.00

* credit balances are shown in brackets

if final claim, tick box ☐

I hereby certify that the actual expenditures detailed above have been necessarily incurred in accordance with the terms and conditions of this Research Scheme and that the estimate is an accurate forecast of expenditure to be incurred to the end of the current period

Signed ..... Research Grants and Contracts Officer

ANNEX 7

Illustrative Diagrams

1. Relation of Projects to Research and Development Cascade

2. Foci of Emphasis in Programme

3. Urban Malaria Management Scenario

4. Environmental Aspects of Malaria

5. Original Design of Activities in Surat District
(N.B. An Indian District is much larger than an African one; population is around 4 million)

6. Effects of a simple vaporizing lamp for pyrethroids upon biting mosquito levels in Dar es Salaam

Strategic

Applied

Efficacy

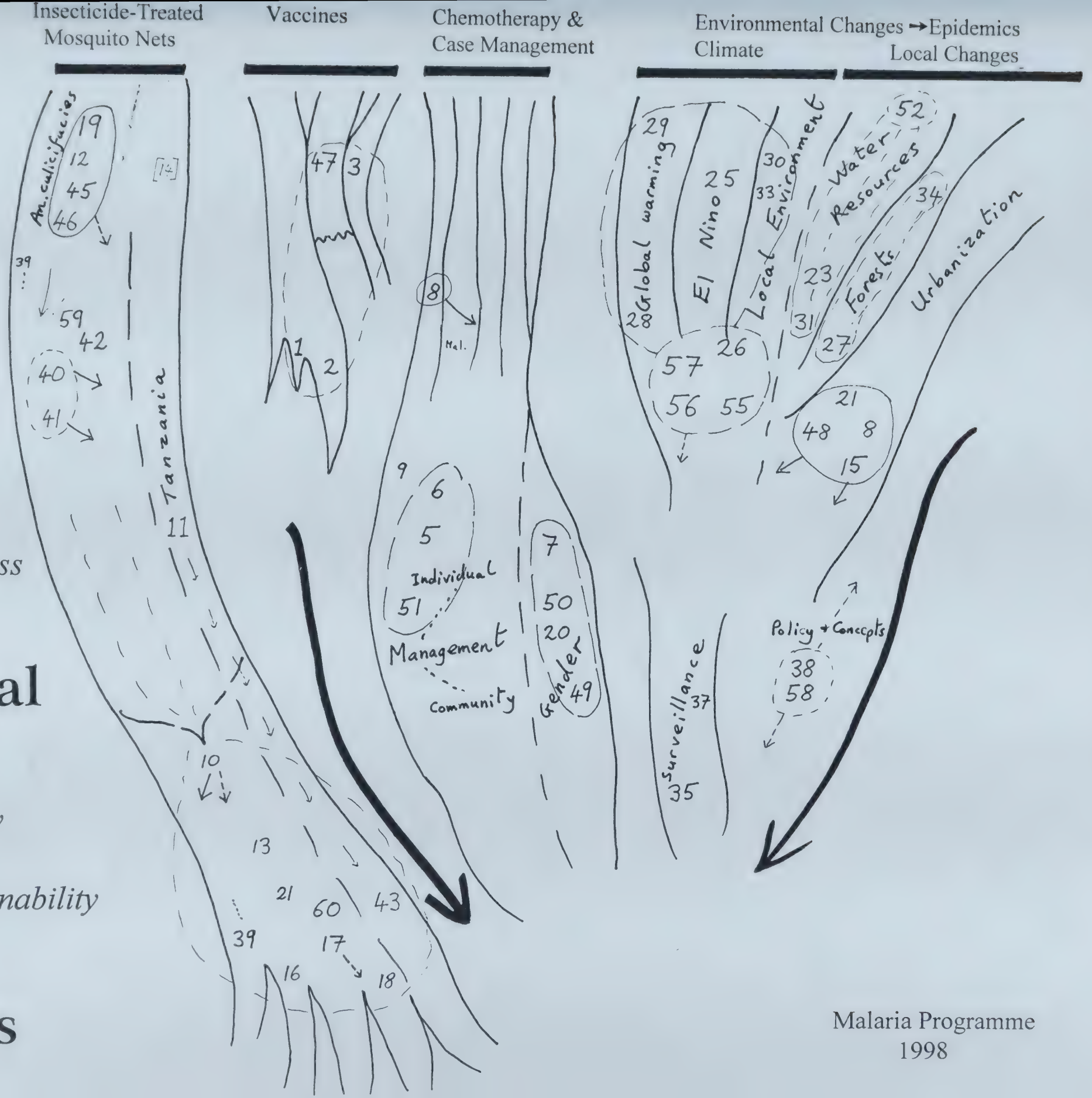
Effectiveness

Operational

Equity

Sustainability

Operations



Relation of Projects to the R & D Cascade

Malaria Programme
1998

Malaria Programme.

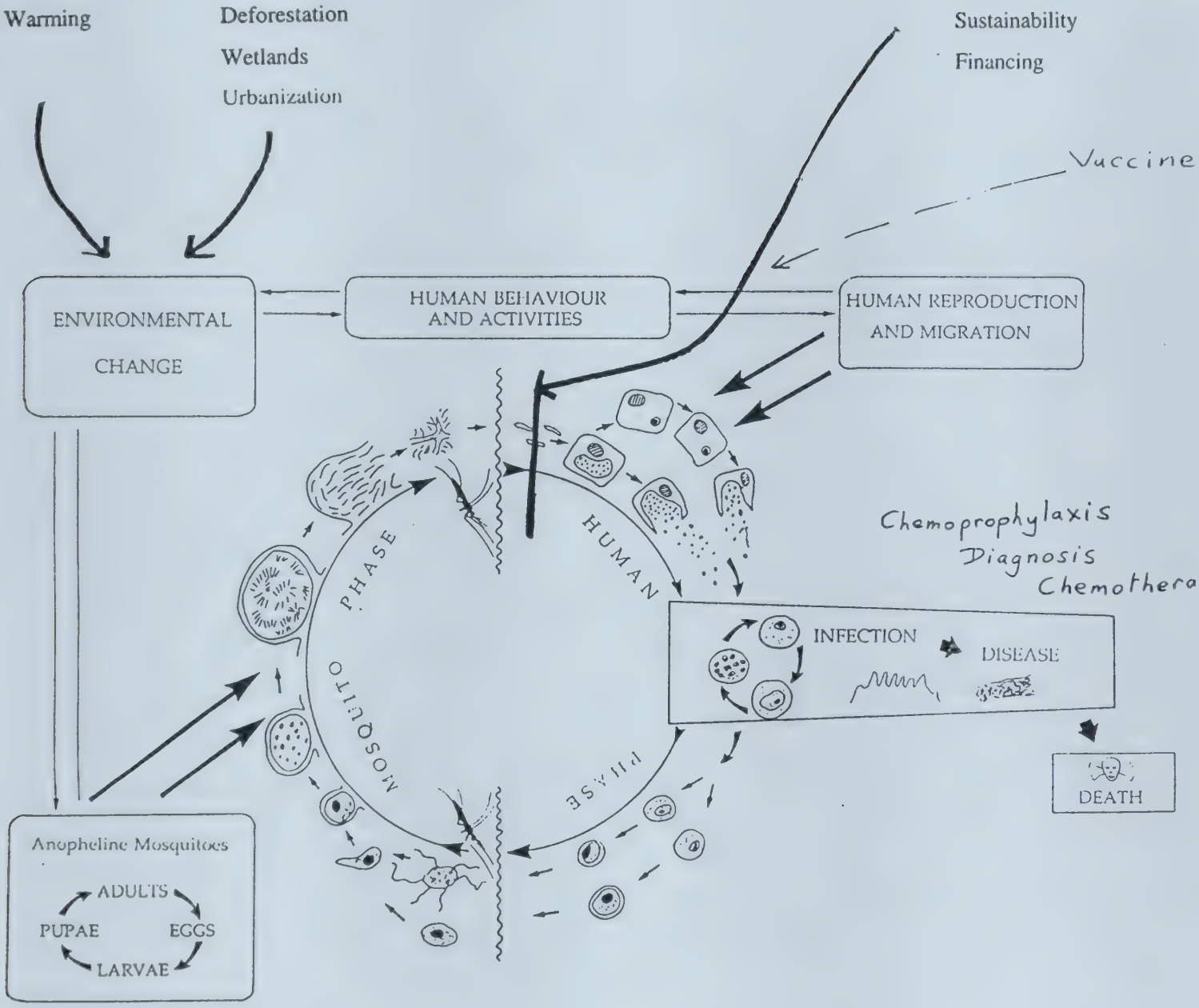
ENVIRONMENTAL CHANGE

GLOBAL
El Nino-Southern Oscillation
Global Warming

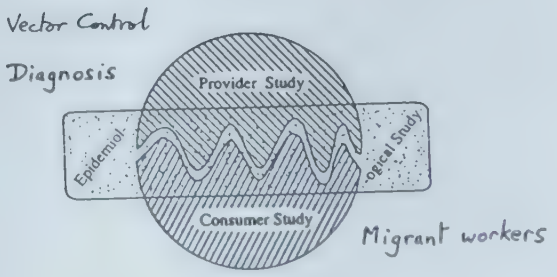
LOCAL
Irrigated Rice
Reafforestation
Deforestation
Wetlands
Urbanization

IMPREGNATED BED NETS
Organization
Marketing
Utilization
Sustainability
Financing

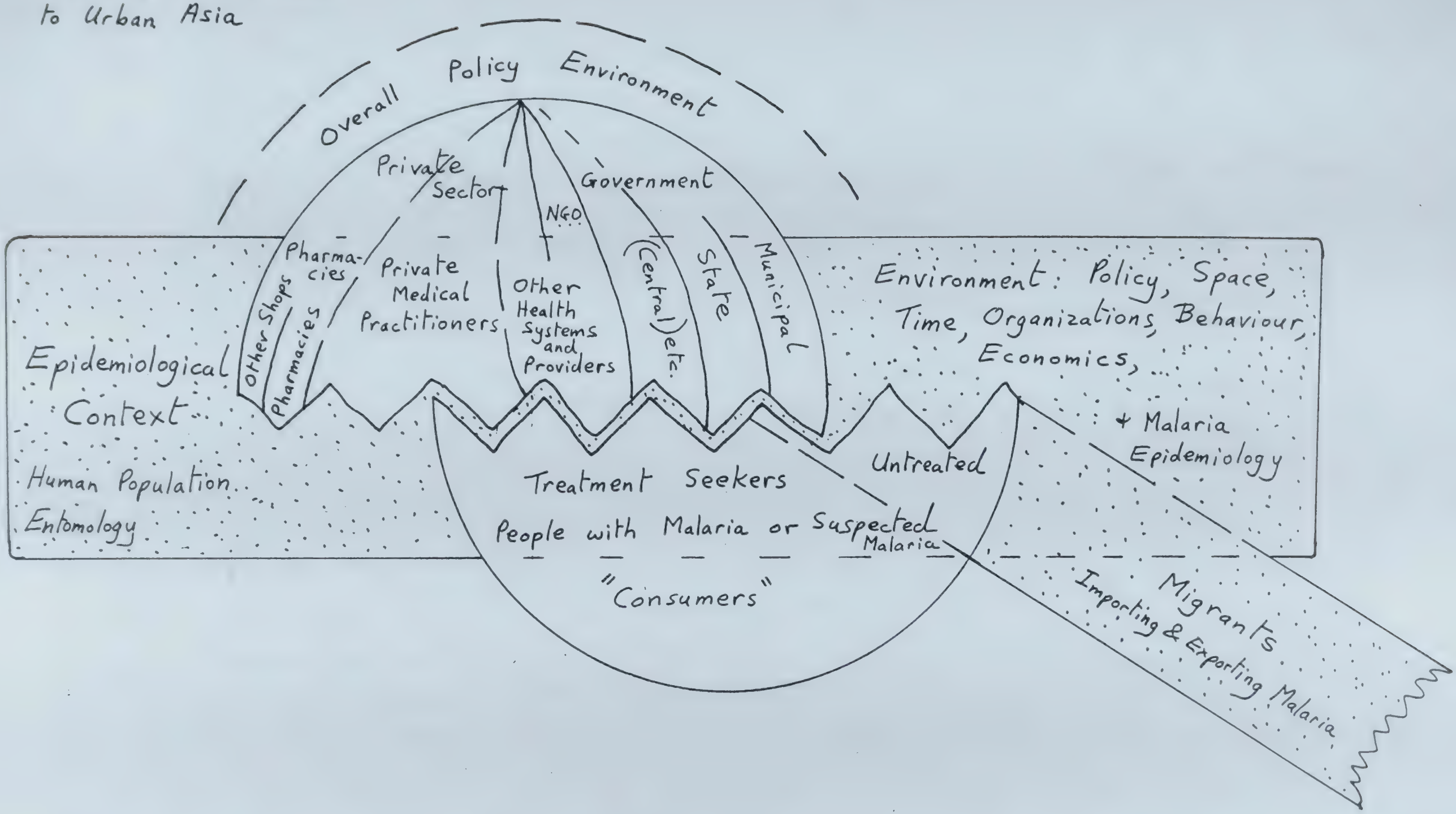
Vaccines



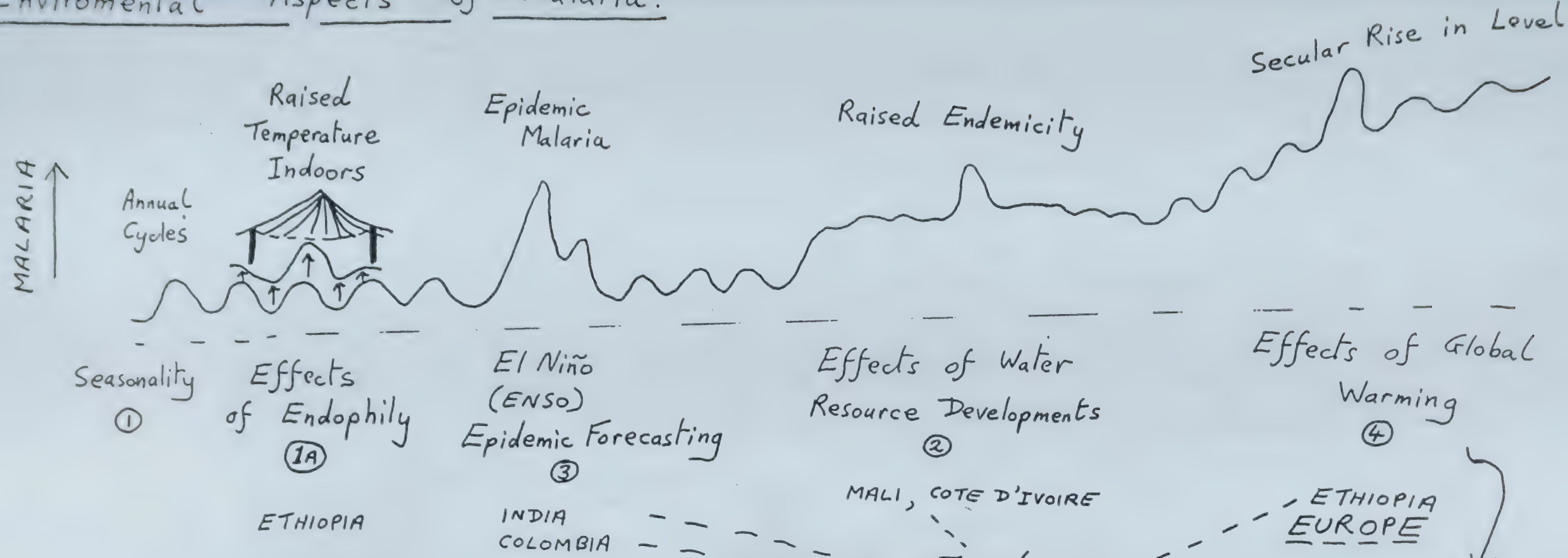
Chemoprophylaxis
Diagnosis
Chemotherapy

	AFRICA	ASIA
URBAN	Insecticide-Treated Bed Nets: Sustainable Implementation +.	 Integrated South Asia urban malaria studies.
RURAL	Several Centres Studies of Malaria Management at Community Level.	An. culicifacies transmitted malaria control trials.

Malaria Management Scenario, with reference to Urban Asia



Enviromental Aspects of Malaria.



Water Resource Developments

W. African irrigated Rice
Irrigation in Gujerat
Wetland conservation & m. Zimb.
?? Agricultural Δ in Uganda.

Deforestation

Asia — (plans).
S. America — Brazil
Indonesia
Forest Malaria : Venezuela

Urbanization

Processes in
1. Asia — Surat City
2. Africa — Dar es Salaam

SURAT PROJECT

GUJARAT STATE AND SURAT

Rural Trial

1. Synthetic Pyrethroid A ×2
2. " " A ×1
3. " " B ×1
4. " " B Bednets ×1
5. Comparison Area

- Epidemiology
- Entomology
- Cost-Effectiveness
- Willingness to Pay
- Sociology
- Institutional Development

OUTCOMES

- Control of Malaria in Surat
- Residual vs. Imp. Bednet
- Best strategy for different eco-areas
- Malaria control model for India?

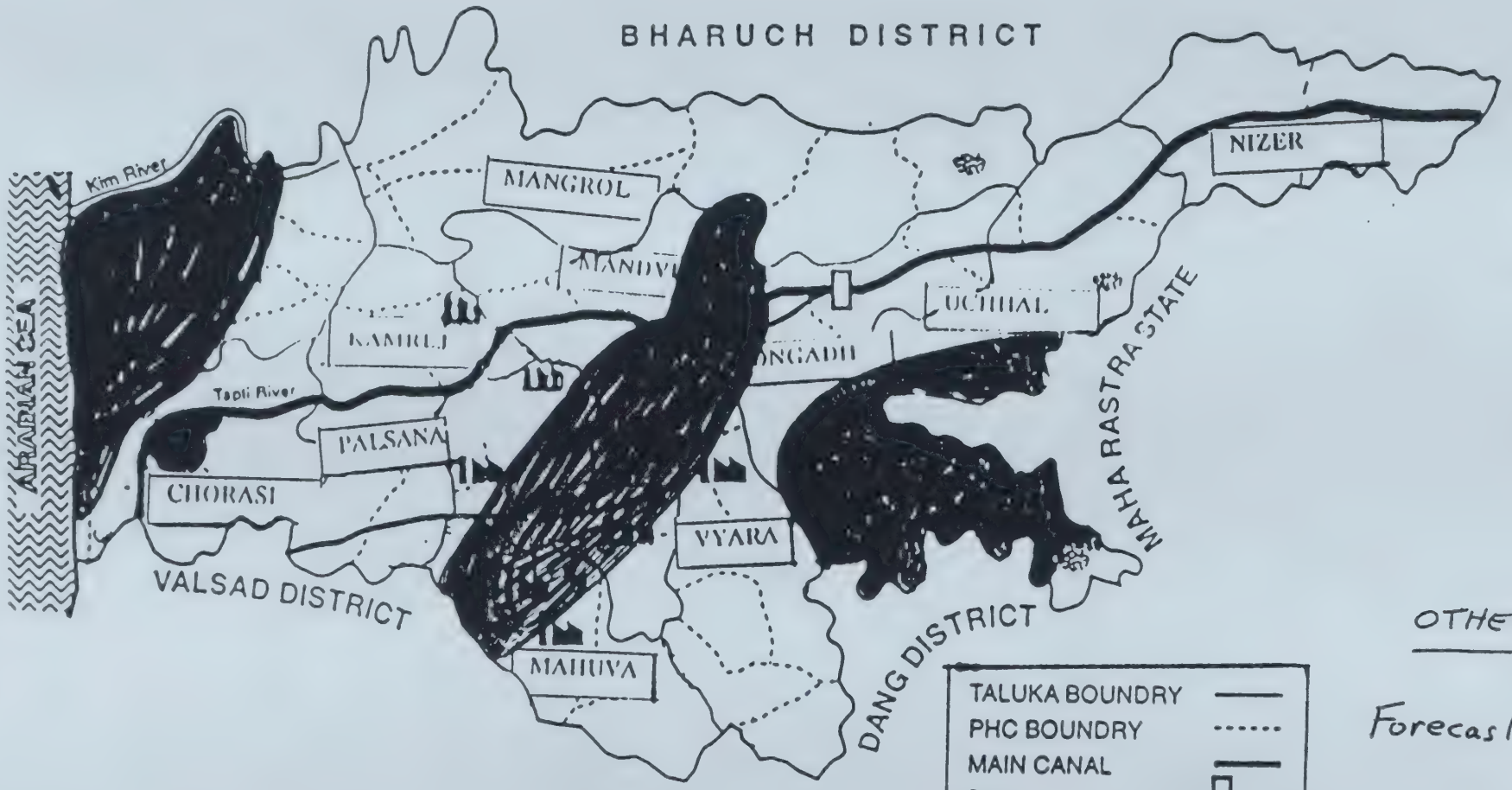
Urban

Sociological study.

Promotion & Use of Bednets.

Migrants + Malaria

Training of Engineers



TRAINING

2 PhD's

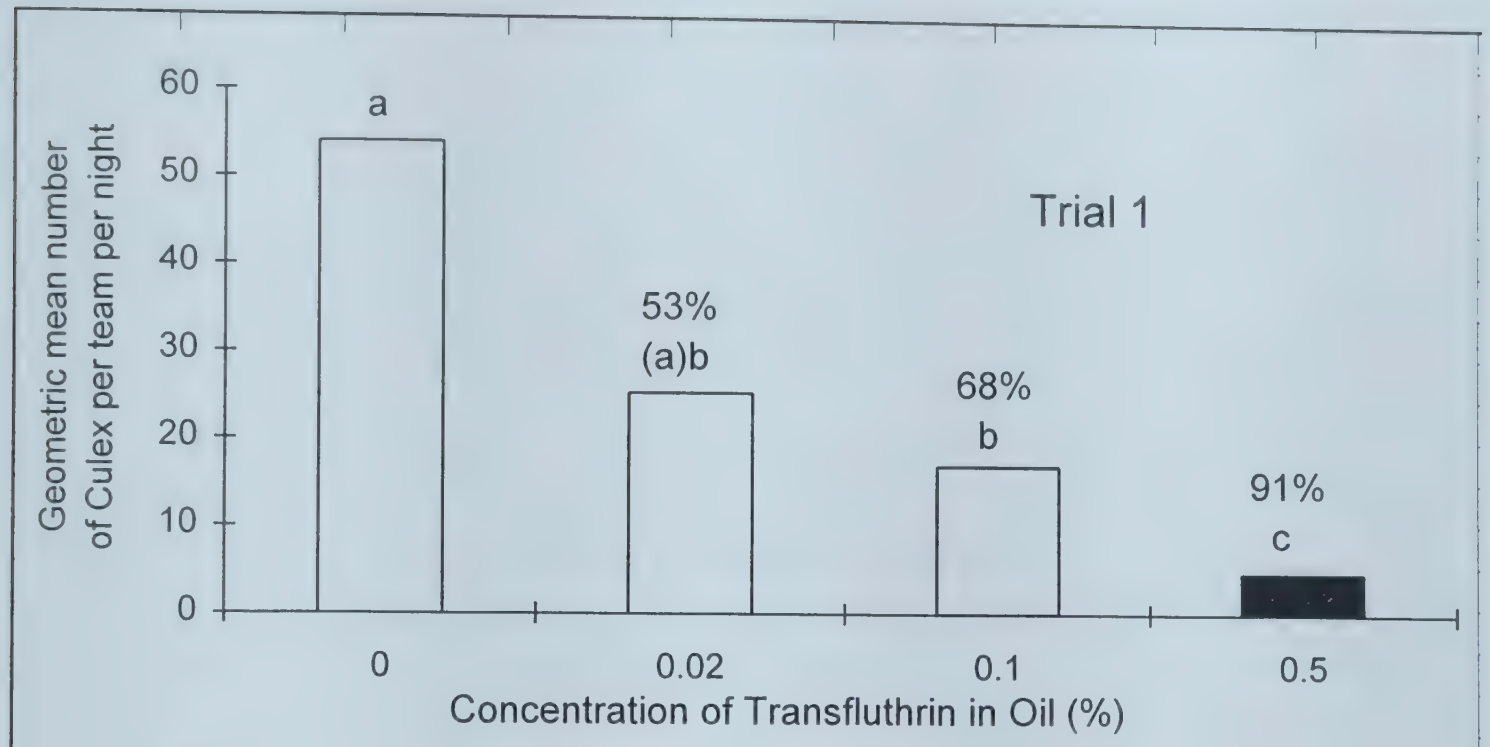
8 M.Sc's

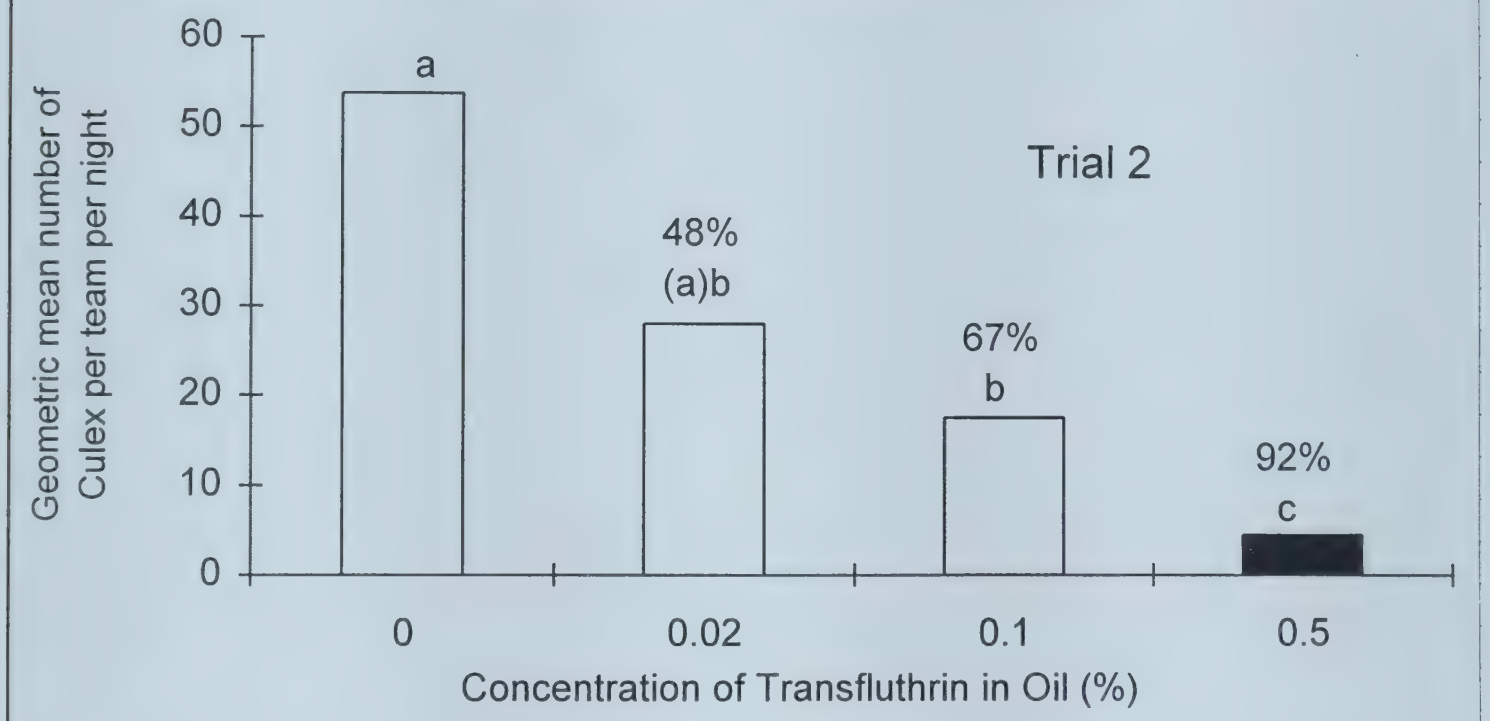
12 Short Course Local Training

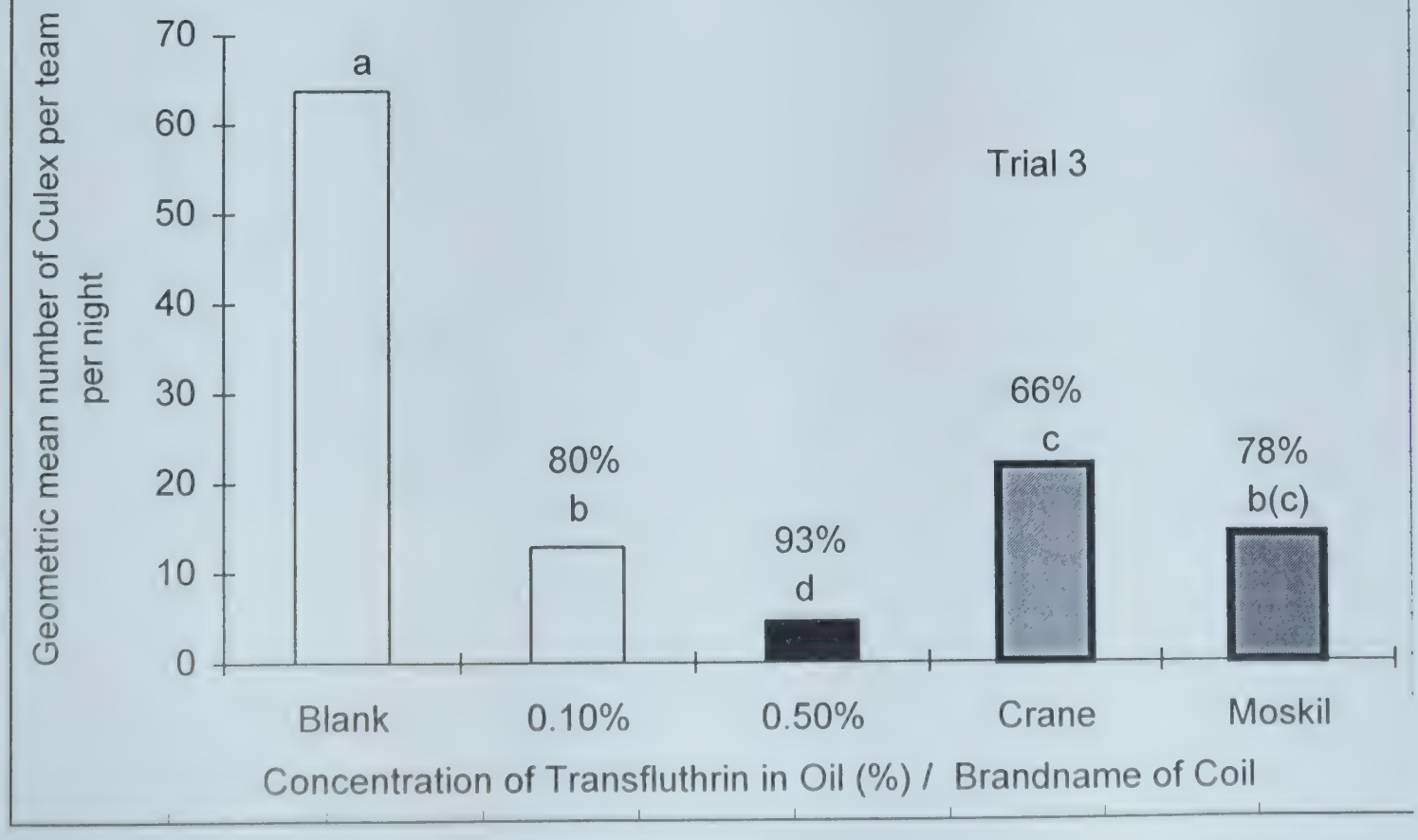
OTHER STUDIES

Forecasting Malaria Epidemics

Public-Private Mix in Providing Malaria Treatment


Geometric mean number of Culex per team per night
60
50
40
30
20
10
0
a
53%
(a)b
68%
b
91%
c
Trial 1
0
0.02
0.1
0.5
Concentration of Transfluthrin in Oil (%)


Geometric mean number of Culex per team per night
60
50
40
30
20
10
0
a
48%
(a)b
67%
b
92%
c
Trial 2
0
0.02
0.1
0.5
Concentration of Transfluthrin in Oil (%)


Geometric mean number of Culex per team per night
70
60
50
40
30
20
10
0
a
80%
b
93%
d
66%
c
78%
b(c)
Trial 3
Blank
0.10%
0.50%
Crane
Moskil
Concentration of Transfluthrin in Oil (%) / Brandname of Coil

PROJECTS

Portfolio and Progress Reports

LIST OF PROJECTS:

P1 Follow-up of children immunised with the malaria vaccine SPf66.

P2 The Ifakara SPf66 Malaria Vaccine Programme

P3 Malaria Vaccine Trial in Papua New Guinea.

P4 Urban Surat: Migrant Worker Study

P5 Clinical predictors and a practical approach to diagnose malaria

P6 Diagnosis of clinical malaria by village health workers

P7 Iron supplementation and malaria in rural Ethiopia.

P8 A randomised placebo controlled trial of the new anti-malarial CGP 56697 in Gambian children.

P9 Failure of chloroquine treatment among malaria patients in the highlands of Ethiopia.

P10 A survey of operational experiences of using pyrethroid-impregnated mosquito nets.

P11 Development of a "dip-it-yourself" kit for home-treatment of mosquito nets in Dar-es-Salaam.

P12 Entomological evaluation of malaria vector control in Surat.

P13 District level systems for distributing nets and insecticide for impregnation.

P15 Guidelines for engineers on urban vector control.

P16 Use of traditional bednets for malaria control.

P17 Orissa Health and Welfare Project Phase II. ITMN Project.

P18 Promotion of impregnated bednets in Solomon Islands.

P19 Malaria Control and Research Project, Surat. (Rural trial, epidemiology).

P20 Control of malaria during pregnancy: an evaluation of the effectiveness of chemoprophylaxis and impregnated bednets.

P21 Urban Surat: Bednet Trial.

P23 Effects of irrigated rice agroecosystems on the amount of malaria and schistosomiasis in West Africa.

P25 Use of the El Nino Southern Oscillation as possible early warning system for epidemic malaria in highland areas.

P26 The potential for epidemic forecasting and containment of irrigation related malaria in Gujarat, India.

P27 Remote sensing in malaria epidemiology.

P28 Modelling of the consequences of global climatic change for malaria endemicity: alternative approaches.

P29 Determinants of malaria transmission in the highlands of Ethiopia: the impact of global warming on morbidity and mortality ascribed to malaria.

P30 Microclimate and temperature variability: implications for the extrinsic cycle of the malaria parasites.

P31 Malaria control and wise use of wetlands.

P33 Global positioning system (GPS) - assisted exploration of factors influencing the spatial distribution of malaria cases by household in the study area of the Bo malaria project, Sierra Leone.

P34 Malaria among Yanomami and Yekwana ethnic groups: a study in the Venezuelan Amazon.

P35 Evaluation of a new surveillance strategy for low level malaria.

P37 Use of 'postcoding' for malaria surveillance from facility-based data sets.

P38 Historical analysis of malaria policy.

P39 A trial of treated nets against malaria in the Upper Orinoco.

P40 Development of an ELISA for measuring pyrethroid deposits on mosquito nets.

P41 Risk assessment of pyrethroid exposure through net treatment and use of treated nets.

P42 Field trial of Alphamethrin for net treatment in Vietnam.

P43 Design of social marketing strategies for nets and net treatment in Tanzania.

P45 Cost effectiveness analysis of malaria control in Surat: impregnated bednets vs residual spray.

P46 Willingness to pay for impregnated bednets in Surat.

P47 A trial of the malaria vaccine RTS,S.

P48 Who cares? The public-private mix in malaria service provision in urban India: towards evidence-based interventions.

P49 Effect of placental malaria on vertical transmission of HIV.

P50 Epidemiology of malaria during pregnancy in Indonesia.

P51 Evaluation of a sick child algorithm in an area with chloroquine resistance.

P52 Population structure of *An.gambiae* in South Africa.

P55 Prediction in China.

P56 Malaria in historical India.

P57 The epidemiology of highland malaria in Ethiopia.

P58 Mathematical models of the immunological and clinical epidemiology of *Plasmodium falciparum* malaria.

P59 A comparative trial of bednets impregnated with alphacypermethrin or lambdacyhalothrin at Muheza, Tanzania.

P60 Design of strategies to incorporate treated nets into the National Malaria Control Programme in India.

P61 Economic evaluation of malaria control in Africa.

P62 Field trial on the acceptability and efficacy of the K-O Tab for the insecticide treatment of mosquito nets.

P63 Vector bionomics in urban Surat.

P64 Sensitivity of malarial parasites in urban Surat.

P65 A Kerosene lamp device for repelling mosquitoes.

LIST OF PROJECTS

By Section of Report

Proj.No.	Topic of Project	Country	Logframe Output #
P62	Field trial on the acceptability and efficacy of the K-O tab for the treatment of nets	Tanzania	1.1.1
P11	Development of a "dip-it-yourself" kit for home treatment of mosquito nets in Dar-es-Salaam.	Tanzania	1.1.1a
P43	Design of social marketing strategies for nets and net treatment in Tanzania.	Tanzania	1.1.1c
P13	District level systems for distributing nets and insecticide for impregnation.	Mozambique	1.1.1d
P59	Comparative trial of nets treated with alphacypermethrin or lambdacyhalothrin at Muheza.	Tanzania	1.1.2a
P42	Field trial of Alphamethrin for net treatment in Vietnam.	Vietnam	1.1.2b
P40	Development of an ELISA for measuring pyrethroid deposits on mosquito nets.	Global	1.1.2c
P41	Risk assessment of pyrethroid exposure through net treatment and use of treated nets.	Global	1.1.2d
P10	A survey of operational experiences of using pyrethroid-impregnated mosquito nets.	Many	1.1.3
P60	Strategies to incorporate treated nets into the National Malaria Control Programme in India.	India	1.1.3
P17	Orissa Health and Welfare Project Phase II. ITMN Project.	India	1.1.4a
P16	Use of traditional bednets for malaria control.	Myanmar	1.1.4b
P18	Promotion of impregnated bednets in Solomon Islands.	Solomon Is	1.1.4c
P39	A trial of treated nets against malaria in the Upper Orinoco.	Venezuela	1.1.4d
P19	Malaria Control and Research Project, Surat. (Rural trial, epidemiology).	India	1.1.5
P45	Cost effectiveness analysis of malaria control in Surat: impregnated bednets vs residual spray.	India	1.1.5c
P12	Entomological evaluation of malaria vector control in Surat.	India	1.1.5d
P46	Willingness to pay for impregnated bednets in Surat.	India	1.1.5e
P47	A trial of the malaria vaccine RTS,S.	The Gambia	1.2a
P1	Follow-up of children immunised with the malaria vaccine SPf66.	The Gambia	1.2b
P2	The Ifakara SPf66 Malaria Vaccine Programme	Tanzania	1.2c
P3	Malaria Vaccine Trial in Papua New Guinea.	PapuaNG	1.2d
P8	A randomised placebo controlled trial of the new anti-malarial CGP 56697 in Gambian children.	The Gambia	1.3.1a
P50	Epidemiology of malaria during pregnancy in Indonesia.	Indonesia	1.3.2.a
P20	Control of malaria during pregnancy: an evaluation of chemoprophylaxis and bednets.	India	1.3.2b
P7	Iron supplementation and malaria in rural Ethiopia.	Ethiopia	1.3.2c
P49	Effect of placental malaria on vertical transmission of HIV.	Zimbabwe	1.3.2d
P5	Clinical predictors and a practical approach to diagnose malaria	India	1.3.3a
P6	Diagnosis of clinical malaria by village health workers	The Gambia	1.3.3b
P51	Evaluation of a sick child algorithm in an area with chloroquine resistance.	Zimbabwe	1.3.3c
P25	Using the El Nino as possible early warning system for epidemic malaria in highland areas.	Many	1.4.1
P26	Potential for epidemic forecasts and containment of irrigation related malaria in Gujarat, India.	India	1.4.2
P63	Vector bionomics in urban Surat	India	2.1.1
P64	Sensitivity of malarial parasites in urban Surat	India	2.1.1
P21	Urban Surat: Bednet Trial.	India	2.1.1a
P48	The public-private mix in malaria service provision in urban India.	India	2.1.1b
P4	Urban Surat: Migrant Worker Study	India	2.1.1c
P15	Guidelines for engineers on urban vector control.	Global	2.1.2
P57	The epidemiology of highland malaria in Africa.	Africa	2.2a
P9	Failure of chloroquine treatment among malaria patients in the highlands of Ethiopia.	Ethiopia	2.2b
P29	Determinants of malaria transmission in the highlands of Ethiopia: impact of global warming .	Ethiopia	2.2b
P30	Microclimate and temperature variability: implications for the extrinsic cycle of malaria.	Ethiopia	2.2c
P56	Malaria in historical India.	India	2.2d
P28	Modelling consequences of global climatic change for endemicity: alternative approaches.	Many	2.2e
P23	Effects of irrigated rice agroecosystems on the amount of malaria in West Africa.	Mali+	2.3a
P31	Malaria control and wise use of wetlands.	Zimbabwe	2.3b
P27	Remote sensing in malaria epidemiology.	Brazil	2.3c
P34	Malaria among Yanomami and Yekwana ethnic groups: a study in the Venezuelan Amazon	Venezuela	2.3d
P55	Prediction in China.	China	2.4a
P35	Evaluation of a new surveillance strategy for low level malaria.	China	2.4b
P37	Use of 'postcoding' for malaria surveillance from facility-based data sets.	India	2.4c
P61	Economic evaluation of malaria control in Africa	Africa	3.1
P38	Historical analysis of malaria policy.	Global	3.1a
P33	Global positioning system-assisted exploration of distribution of malaria in Bo.	Sierra Leone	3.2a
P52	Population structure of An.gambiae in South Africa.	South Africa	3.2b
P58	Mathematical models of the immunological and clinical epidemiology of falciparum malaria.	Global	3.2e
P65	A Kerosene lamp device for repelling mosquitoes	Tanzania	

LIST OF PROJECTS

By Country

Proj.No.	Topic of Project	Country	Logframe Output #
P57	The epidemiology of highland malaria in Africa.	Africa	2.2a
P61	Economic evaluation of malaria control in Africa	Africa	3.1
P27	Remote sensing in malaria epidemiology.	Brazil	2.3c
P35	Evaluation of a new surveillance strategy for low level malaria.	China	2.4b
P55	Prediction in China.	China	2.4a
P7	Iron supplementation and malaria in rural Ethiopia.	Ethiopia	1.3.2c
P9	Failure of chloroquine treatment among malaria patients in the highlands of Ethiopia.	Ethiopia	2.2b
P29	Determinants of malaria transmission in the highlands of Ethiopia: impact of global warming .	Ethiopia	2.2b
P30	Microclimate and temperature variability: implications for the extrinsic cycle of malaria.	Ethiopia	2.2c
P15	Guidelines for engineers on urban vector control.	Global	2.1.2
P38	Historical analysis of malaria policy.	Global	3.1a
P40	Development of an ELISA for measuring pyrethroid deposits on mosquito nets.	Global	1.1.2c
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P12	Entomological evaluation of malaria vector control in Surat.	India	1.1.5d
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P57	The epidemiology of highland malaria in Africa.	Africa	2.2a
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P60	Strategies to incorporate treated nets into the National Malaria Control Programme in India.	India	1.1.3
P61	Economic evaluation of malaria control in Africa	Africa	3.1
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P65	A Kerosene lamp device for repelling mosquitoes	Tanzania	

TITLE OF PROJECT: Follow-up of children immunised with the malaria vaccine SPf66.

COUNTRY: The Gambia.

STAFF RESPONSIBLE: Brian Greenwood, Geoff Targett, Michelle Heywood.

OVERSEAS COLLABORATORS: Dr Kalifa Bojang, Dr Steve Obaro, MRC Laboratories, The Gambia.

FUNDING: UK Medical Research Council.

DURATION: 1995-1997.

SUMMARY:

A trial of the malaria vaccine SPf66 was undertaken in Gambian infants in 1994. Initial results were not encouraging as only 8% protection against clinical attacks of malaria was observed. However, because the malaria transmission season is only short in The Gambia, follow-up was maintained for only four months after the course of vaccination was completed. Studies carried out with SPf66 elsewhere have suggested that the protective effect of the vaccine may not become apparent until several months after vaccination. Therefore, children in the Gambian trial were followed throughout the 1995 and 1996 rainy seasons. No evidence of protection was found during this extended period of follow up.

Antibody levels to SPf66 have been measured in samples collected after completion of vaccination. About 90% of immunised children showed an increase in antibody levels after vaccination but children with high level antibody levels were no better protected than children with low antibody levels.

Malaria parasites obtained from children vaccinated with SPf66 and from control children have been typed using molecular typing methods. Using primers to polymorphic alleles of the antigens MSP1, MSP2 and GLURP it has been shown that the number of genotypes present in SPf66-vaccinated children with parasitaemia was less than the number found in control children. This suggests that SPf66 had some effect on the incidence of new malaria infections in Gambian children although it did not reduce signifcantly the incidence of clinical attacks or the prevalence of parasitaemia.

TITLE OF PROJECT:	The Ifakara SPf66 Malaria Vaccine Programme
COUNTRY:	Tanzania
STAFF RESPONSIBLE:	Professor Brian Greenwood (WHO Trial Monitor)
OVERSEAS COLLABORATION:	Swiss Tropical Institute; Tanzanian National Institute for Medical Research; Unidad de Epidemiologia y Bioestadistica, Hospital Clinic I Provincial.
FUNDING:	Spanish Agency for International Cooperation; Swiss Development Cooperation
DURATION:	1996 - 2000

SUMMARY:

An initial trial of the malaria vaccine SPf66 in Tanzanian children aged 1-5 years demonstrated a 31% reduction in first attacks of malaria. Because it is essential that a malaria vaccine is given in early childhood if it is to have its maximum a further study of SPf66 in Gambian infants is being undertaken.

A randomized, double-blind, placebo-controlled study of the safety of SPf66, its immunogenicity, potential interactions with EPI vaccines and efficacy against clinical episodes of malaria is being carried out among 1,200 infants born at the St. Francis designated District Hospital, Ifakara. This study will have enough power to detect a 25% reduction in the incidence of malaria episodes.

Professor Greenwood made his second monitoring visit in September 1997. At the time of this visit 1,207 children had been recruited all of whom have now received 3 doses of SPf66 vaccine or placebo. Excellent follow-up has been obtained and many children in the trial have been admitted to hospital with malaria. Follow-up will be completed around the end of 1998.

TITLE OF PROJECT: Malaria Vaccine Trial in Papua New Guinea.

COUNTRY: Papua New Guinea.

STAFF RESPONSIBLE: David Bradley (Clinical Trial Monitor).

OVERSEAS COLLABORATORS: PNG Institute for Medical Research, Prof. Michael Alpers.

FUNDING: Hoffman La Roche (manufacturers).

DURATION: 1996 -

SUMMARY:

A new recombinant vaccine has been developed and is beginning to undergo field trials. Safety trials are currently under way and on their successful completion subsequent phases will be undertaken.

There have been few communications from the project in recent months. As Prof. Alpers has been ill, and the funding of the project has passed from Roche to other sources, there were some concerns about progress.

28 February 1998 - The next phase of the trial is now beginning.

TITLE OF PROJECT: Urban Surat: Migrant Worker Study

COUNTRY: India

STAFF RESPONSIBLE: Caroline Jones, Daniel Chandramohan

OVERSEAS COLLABORATORS: Dept. Social and Preventive Medicine, Surat.

FUNDING: DFID

DURATION: 1997 - 2000

SUMMARY:

Surat City attracts people from all parts of India and it is widely believed that the high level of migration into the Municipality is a major contributing factor to the presence of malaria in the urban area. However, the actual scale of the problem and the effect that migration has on the health of the sedentary urban population has not been quantified. One of the main obstacles to such quantification is the fluidity of migrant group composition. Many migrants move into the city during periods of hardship and return to their native villages for events such as the harvest. If the aims of the Surat Malaria Research and Control Project are to be met then the health problems of these migrants and their impact on the malaria status of the sedentary population need to be investigated. This study is part of an inter-linked series of projects that will provide a complete description of malaria from the point of view of the residents (both migrant and sedentary) of urban Surat. The particular aims of this project are:

To compile background information on the various types of migrant groups in Surat city.

To study the health profiles of the various migrant groups.

To investigate the concepts that are held by selected migrant groups about the origins and nature of malaria and fever.

To investigate the preventive and treatment seeking behaviour of members of those groups as well as the position of malaria prevention in relation to their other priorities.

To carry out follow-up studies of the health profiles and problems of regular migrants in relation to their immigration and emigration practices between Surat and their native villages.

The baseline survey and supplementary survey have been completed in all four study areas. The social science research team have identified the socio-cultural and language groups in each of the four urban study areas and have started the collection of detailed qualitative data on beliefs and treatment seeking behaviour. Active case detection and the monitoring of movements into and out of the community are continuing.

TITLE OF PROJECT: Clinical predictors and a practical approach to diagnose malaria

COUNTRY: India

STAFF RESPONSIBLE: Daniel Chandramohan & Brian Greenwood

OVERSEAS COLLABORATORS: Dr V K Desai, Department of Preventive and Social Medicine, Surat

FUNDING: DFID

STUDY PERIOD: 1997-1998

SUMMARY:

The reliability and accuracy of a clinical diagnosis of malaria reached without confirmatory laboratory evidence is debatable since the signs and symptoms of malaria overlap with many other infectious diseases. However, laboratory facilities to diagnose malaria are often not available in many developing countries particularly in rural areas. Few attempts have been made in Africa to identify predictors of clinical malaria and to evaluate a rapid dipstick antigen-capture assay to diagnose malaria. However, such studies have not been reported from India where a multi purpose peripheral health worker is assigned for every 5000 population to diagnose and treat all acute febrile illnesses with limited support from the primary health centre laboratories. This study aims to identify combinations of clinical signs and symptoms with optimal sensitivity and specificity which could be used by peripheral health workers to diagnose malaria.

This work will contribute to the control of malaria in India by providing a tool to improve the diagnostic skills of peripheral health workers.

The data collection for this project is starting in June 1998 and will be completed in December 1998.

TITLE OF PROJECT: Diagnosis of clinical malaria by village health workers

COUNTRY: The Gambia

STAFF RESPONSIBLE: Brian Greenwood, Linda Williams

OVERSEAS COLLABORATION: Dr Kalifa Bojang, Dr Steve Obaro
MRC Laboratories, The Gambia

FUNDING: UK Medical Research Council

DURATION: 1995-7

SUMMARY:

Diagnosis of clinical malaria is difficult, even when laboratory facilities are available. It is even more difficult when, as is the case in many parts of tropical Africa, health providers have to rely solely on symptoms and clinical signs for features such as fever are common to many other infectious diseases. Thus, it will never be possible to develop a set of clinical criteria that will differentiate malaria from other febrile illnesses with certainty. Nevertheless, in practice, many health workers have to do this as best as they can.

In 1994, a study was undertaken in The Gambia which identified symptoms and signs which predicted a diagnosis of malaria in febrile Gambian children. These were used to develop a diagnostic score, the magnitude of which indicated the probability of a child having malaria. A score of 7 was found to have a sensitivity and specificity of approximately 80%.

During 1995/96 the scoring system was tested prospectively in a group of 520 febrile children who presented to the MRC field station at Basse, The Gambia. Using the scoring system the accuracy of two field assistants in making a diagnosis of malaria was found to be equivalent to that of an experienced paediatrician using his clinical skills alone without the benefit of microscopy.

It is intended to test this approach in other malaria endemic areas.

TITLE OF PROJECT: Iron Supplementation and malaria among women and children in rural Ethiopia.

COUNTRY: Ethiopia.

STAFF RESPONSIBLE: Joanne Morris, Zenaw Adam.

OVERSEAS COLLABORATORS: University of Addis Ababa.

FUNDING: McGill, University of Montreal.

DURATION: 1996.

SUMMARY:

Background: Prevention and control of iron deficiency and anaemia in most developing countries relied much on routine supplementation of elemental iron. Epidemiological observations and animal experiments in recent years, however, have shown conflicting results on the role of repletion with elemental iron and its effect on malaria and other infections.
Objectives: This study was planned primarily to determine and estimate the risk and magnitude of clinical malaria among women and children under oral iron supplementation. The study has also a secondary objective of evaluating the response to oral iron supplementation among women and children.
Methods: Women aged 15-49 and children below the age of 7 living in a malarious area who fulfilled a set of selection criteria were randomised into two treatment groups. A double blind procedure was used to allocate oral iron and a look alike placebo tablet and syrup to women and children respectively. Subjects under supplementation were followed for a total of one year including the 12 weeks of treatment. Data on clinical assessment, blood film examination and bi-weekly house to house morbidity data was collected on each subject.
Results: Preliminary analysis of data indicates both women and children in the iron group to have experienced more malarial episodes than their counterparts. Prevalence of malariometric indices among children in the iron group have consistently exceeded estimations among the placebo group. Rates of febrile episodes, diagnosis of clinical malaria, splenomegaly, and parasitaemia among the iron and placebo groups were 68.9% & 58.9%, 19.6% & 13.2%, 27.4% & 19.1%, 34.6% & 27.1% respectively. Similarly, preliminary estimates of febrile episodes, clinical diagnosis of malaria and parasitaemia among women in the iron and placebo groups were 62.4% & 53.2%, 24.1% & 18.2%, 29.7% %20.4% respectively.

The thesis was completed in 1997.

TITLE OF PROJECT: A randomised placebo controlled trial of the new anti-malarial CGP 56697 in Gambian children.

COUNTRY: The Gambia

STAFF RESPONSIBLE: Brian Greenwood

OVERSEAS COLLABORATION: Dr L von Seidlein, Dr Jones, Dr Bojang, Dr Doherty (MRC Laboratories, The Gambia), Dr Royce, Novartis, Basle, Switzerland.

FUNDING: Novartis (Ciba-Geigy)

DURATION: July 1996 - December 1996

SUMMARY:

Chloroquine resistant P.falciparum is now widespread in many parts of Africa. Fansidar® (pyrimethamine + sulphadoxine) is the usual alternative choice to chloroquine but Fansidar® resistance has been found in many parts of Africa and there is some evidence that Fansidar® is not very effective at controlling symptoms during the first few days after the start of treatment. Thus, there is likely to be a need for new antimalarials to treat malaria in African children in the near future.

Artemether, a derivative of the plant Artemesia annua has been used successfully to treat severe malaria in both S.E. Asia and in Africa. However, recrudescences after treatment are common and in S.E. Asia artemisinins are frequently given with mefloquine. To try to overcome this problem artemether has been combined with a novel antimalarial, benflumetol, in a fixed combination of 1:6 to give a new drug called CGP 56697. A pilot trial undertaken in 60 Gambian children in 1995 showed that the drug was safe and effective. Other trials have been completed successfully in Tanzania and in South East Asia.

On the basis of the results of the safety trial a larger trial was undertaken in 1996 in which CGP 56697 was compared with Fansidar® in the treatment of uncomplicated falciparum malaria in 287 Gambian children aged 1-5 years. Children treated with CGP 56697 resolved their fever and their parasitaemia faster than did children treated with Fansidar®. On day 4 after the start of treatment none of 140 children given CGP 56697 had parasitaemia, whilst 8 of 143 children treated with Fansidar® were still parasitaemic. However, second infections during the period 14-28 days after the start of treatment were more frequent in children who received CGP 56697 than those who received Fansidar®. Molecular biological studies done at LSHTM showed that the majority of these second infections were probably reinfections indicating a shorter chemoprophylaxis effect for CGP 56697 than for Fansidar®.

On the basis of the trials conducted in The Gambia and elsewhere it is likely that CGP 56697 will be registered in the UK later in 1997.

TITLE OF PROJECT: Failure of chloroquine treatment among malaria patients in the highlands of Ethiopia.

COUNTRIES: Ethiopia.

STAFF RESPONSIBLE: Assefa Tulu, Roger Webber, Jo Schellenburg, David Bradley.

OVERSEAS COLLABORATORS: Desk Study.

FUNDING: WHO/TDR, DFID Programme.

DURATION: 1996.

SUMMARY:

The failure of chloroquine treatment among malaria patients has been previously reported in the lowlands of Ethiopia. However, no investigations were carried out in the highlands where malaria in unstable and periodic epidemics of vivax and falciparum malaria are common. A modified seven-day in-vivo field test among 459 patients with vivax malaria demonstrated that 98% of patients cleared asexual parasites. In contrast, only 14% of 60 patients with P.falciparum cleared asexual parasites suggesting a high prevalence of chloroquine resistant strains. Chloroquine resistance was classified as RI/S in 14% , RII in 62% and RIII in 24%. Among a further 80 patients who were given sulphadoxine-pyrimethamine and studied as above, only one patient was unable to clear asexual parasites and remained febrile. These findings suggested that there is a need for further research in wider geographical areas in the highlands of Ethiopia. These results have been published.

TITLE OF PROJECT: A survey of operational experiences of using pyrethroid-impregnated mosquito nets.

COUNTRIES: Global.

STAFF RESPONSIBLE: Desmond Chavasse, Jo Lines, Sylvia Meek.

OVERSEAS COLLABORATORS: Katie Reed of Net Gain;
Managers of operational programmes and specialists in the field of malariology.

FUNDING: To be sought from DFID.

DURATION: 1996-1998.

SUMMARY:

The potential of impregnated bed nets as a public health intervention has been clearly demonstrated by the recently completed WHO/TDR mortality trials in Africa. Questions about the efficacy of this technology in ideal conditions are no longer as important, in many places, as those concerning its effectiveness in practice. This in turn must depend on how implementation is carried out.

The managers of the first generation of operational treated net schemes were the pioneers of the technology who leaned by experience. Decisions had to be made on distribution structures; financing mechanisms; the type and source of nets and insecticide; retreatment structure and protocol as well as promoting the scheme. As yet no consensus on the best approach has emerged because the experiences of the first generation of schemes are not widely published therefore new projects continue to be planned without the benefit of even the basic lessons of other projects. The aims of this project are:

(1) To document the structures and strategies that have been adopted in a wide variety of previous net impregnation schemes and to relate these to operational successes and failures. (2) To record what project leaders, local health authorities, and members of the target population consider to be the most important lessons for the future. (3) To write guidelines on the implementation of treated net schemes for future net scheme mangers. The main text of the guidelines will outline the issues which need to be addressed and present the options for each of the issues. Information on policies, procedures and lessons learned from the case studies will be presented in text boxes and used to illustrate the main text.

The first draft is complete and is being circulated for comments before final editing and publication.

TITLE OF PROJECT: Development of a "dip-it-yourself" kit for home-treatment of mosquito nets in Dar-es-Salaam.

COUNTRIES: Tanzania.

STAFF RESPONSIBLE: Jo Lines, Jane Miller, Caroline Jones

OVERSEAS COLLABORATORS: Professor J. Minjas, Muhimbili Medical University, Population Services International (PSI)

FUNDING: DFID, WHO/TDR

DURATION: 1½ years

SUMMARY:

The project ends in April 1998. A set of instructions adapted for use in Dar es Salaam have been developed and field-tested. User's reactions to the kit have been mostly enthusiastic, though there are some anxieties over toxicity. People who cannot read readily and spontaneously enlist the help of relatives or neighbours who can, and in general the kit is found to be easy to use, and is used safely.

The instructions have been further modified for use in rural Tanzania (Ifakara) and are now in routine use in a social marketing project there.

There remains important questions about the insecticide deposits on nets treated with the kit, which show wide variability, and there is evidence that insecticide can build up rapidly with frequent washing and retreatment.

The project has contributed to the development of a large ODA supported social marketing project in Tanzania, which will be managed by PSI and will use the kit as the principal means of distributing insecticide.

TITLE OF PROJECT: Entomological evaluation of malaria vector control in Surat.

COUNTRIES: India.

STAFF RESPONSIBLE: Jo Lines (Shyam Misra, Roger Webber)

OVERSEAS COLLABORATORS:

FUNDING: DFID/Government of India.

DURATION: 1995-2000.

SUMMARY:

In this trial, entomological evaluation is an important but secondary outcome measure. Its aim is to provide an indication whether any detected impact on the primary epidemiological outcomes is due mainly to a "mass effect" on the vector population, or to individual "personal protection".

Data cleaning and preliminary descriptive analysis is currently being carried out. The early results suggest that light-trapping is more useful than human bait catches in the conditions of this trial, and that spray catches yield by far the largest numbers of vector females, compared to other sampling methods.

Human bait catches have now been abandoned, and attempts have been made to improve the regularity and reliability of the entomological sampling teams, which was poor in the first year.

TITLE OF PROJECT: District level systems for distributing nets and insecticide for impregnation.

COUNTRIES: Mozambique.

STAFF RESPONSIBLE: Martinho Dgedge (PhD student), Jo Lines, Caroline Jones, Lilani Kumaranayake

OVERSEAS COLLABORATORS: Birthe Hogh, Statens Seruminstitut, Copenhagen.

FUNDING: Statens Seruminstitut.

DURATION: 1995-1998.

SUMMARY:

The aim is to explore methods of distribution through existing health structures in and around the town of Boane, near Maputo.

The commercial market in nets is very undeveloped in this area: nets are available only in a few shops in Maputo and at very high prices. The project has succeeded in selling large numbers of nets at prices close to the factory cost. Insecticide is being distributed by means of a communal treatment service. The results of the first round of re-treatment were disappointing, and other approaches are being explored.

This study is taking place in a fully censused population, allowing detailed recording of who is and is not buying nets and insecticide. Willingness-to-pay studies have been carried out, and the results are being compared with actual sales, and with household data on socio-economic status.

TITLE OF PROJECT: Guidelines for Engineers on Urban Vector Control.

COUNTRIES: Urban; Global.

STAFF RESPONSIBLE: Jo Lines, Pete Kolsky, Des Chavasse.

OVERSEAS COLLABORATORS:

FUNDING: Recently approved by PEEM

DURATION: 1994-

SUMMARY:

Presently, there are no books or manuals which tell those responsible for the development and maintenance of the urban environment how not to grow disease vectors such as mosquitoes. The purpose of this project is to produce such a book. It should be accessible to non-specialists and should explain how to reduce insect vector breeding as distinct from chemical control of adults. Such a book will help create an awareness of the link between specific environmental features and specific disease vector problems. The most important urban vector-borne diseases (malaria, dengue and filariasis) are mosquito-borne and the book will concentrate on these in a regionally-specific manner. Since nuisance-biting, rather than disease, tends to be the main reason why the residents of tropical cities worry about insects, due attention will be paid to the control of non-vector nuisance species.

In terms of control methodology, the emphasis will be on preventative measures. Due attention will be paid to the organization and timing of interventions and to the importance of coordination between institutions and organizations. The book will cover cities in tropical Africa, Latin America and the Caribbean, South Asia and Southeast Asia where the need is greatest. In many cases the information provided will also be relevant to cities elsewhere such as North Africa and the Eastern Mediterranean.

Each regional section will consist of (i) a brief description of which vector problems are important, and why, (ii) for each vector species, a prioritised list of breeding sites and recommended actions for each; (iii) one or more birds-eye drawings to link particular vectors with particular environmental features.

Local collaborators with relevant experience in entomology and engineering will be identified in each region. By creating a regional consensus of expertise the guidelines should be applicable in all urban areas through out a particular region.

TITLE OF PROJECT: Use of Traditional Bednets for Malaria Control.

COUNTRY: Myanmar (Burma)

STAFF RESPONSIBLE: Roger Webber.

OVERSEAS COLLABORATORS: Dr Khin Lin, Malaria Programme, Myanmar.

FUNDING: Insecticides donated by Zeneca Public Health

DURATION: 1995 - 1996

SUMMARY:

There is a strong tradition to use bednets in the Shan State of Myanmar which are bought at cost price from local tailors. A small trial was set up in 1996 to see if those without mosquito nets can be encouraged to buy them and to use insecticide treated mosquito (ITMN) nets for malaria control. A secondary intention of this low cost trial is to provide a means of malaria control to be copied by insurgent forces that cannot be approached by the malaria services. A large part of Shan State is in rebel hands.

The trial is in Ho Peik, near Lashio, which consists of 7 well demarcated hamlets and a total population of 1017. Three of the hamlets have nets impregnated with lambda-cyhalothrin and the other have untreated nets. The hamlets are either Shan, Wa or Chinese so have been matched by ethnic group before randomising for the impregnation.

56.9% of people were using nets at the start of the trial. Promotion of nets was then undertaken by village midwives with a message that the use of nets would prevent malaria and dengue. Health promotion took place during routine house visits and at clinics, no special meetings were held. 73.8% were using nets after this promotional phase, the majority buying them at current market prices, but three months after the health-education programme 50 nets were donated by UNDP and these were sold at half price to poor and deserving cases.

The first insecticide treatment (free of charge) was made in September 1996, towards the end of the transmission season. The second will be in May 1997 after which a questionnaire will be administered to seek attitudes to purchasing nets and their treatment.

TITLE OF PROJECT: Orissa Health and Welfare Project Phase II. ITMN Project.

COUNTRY: India

STAFF RESPONSIBLE: Roger Webber

OVERSEAS COLLABORATORS: Ian Pett, Alison Dembo-Rath (OHFWP/British Council, Orissa), CARE, Orissa and MRC, Orissa.

FUNDING: DFID

DURATION: 1994 - 1996

SUMMARY:
An in-depth socio-economic survey found that 87% of people had a knowledge of malaria and 80% knew that it was transmitted by mosquitoes. They were familiar with mosquito nets, but only 10% owned one. However 90% were willing to buy a net and 66% said they would pay Rs 50 (the modal value) or more per net. The preferred method of payment was in five instalments. This compared with the cost of contracting malaria, which amounted to Rs 78 for treatment and Rs 210 for working days lost.

Women's groups were trained in malaria and accounting procedures. They agreed on a standard sized net (that sleeps three people), made locally at a cost of Rs 150. Each women's group was given an initial sum of Rs 3000 which was replenished against nets sold. Money recovered from the sale of impregnated nets could be used for malaria activities, including the purchase of insecticide after the end of the project. Nets are impregnated with Deltamethrine at 25mg m^{-2} by the women, using a standard measure for each net.

By the end of the project 5,356 (92%) of the 5,822 households had bought at least one mosquito net, and 1,762 households had bought at least two, representing a population coverage of approximately 80% (as 3-4 persons sleep under each net). Surveillance data showed a reduction in the Annual Parasite Incidence (API) from 65.6/000 in 1994 to 32.8/000 in 1996, while a mass blood survey in 1996 found a reduction in the Slide Positivity Rate (SPR) from 17.2 to 7.4/000 and the P.falciparum rate from 10.3 to 5.9/000 as compared with a non-intervention area. A re-infection rate study found a P.falciparum rate in the ITMN group to be 3.95 as compared to 25.87 in the comparison group, after 14 months follow-up.

TITLE OF PROJECT:	Promotion of Impregnated Bednets in Solomon Islands.
COUNTRY:	Solomon Islands
STAFF RESPONSIBLE:	Roger Webber, Sylvia Meek.
OVERSEAS COLLABORATORS:	UK Foundation for the South Pacific (UKFSP), Solomon Islands Development Trust.
FUNDING:	DFID
DURATION:	1995 - 1998

SUMMARY:

The research work of Dr Nathan Kere showed that permethrin impregnated bednets were more effective than DDT residual spraying in Solomon Islands. As a result the national policy was changed to use impregnated bednets for malaria control, and this project examines ways in which they can best be promoted.

The most cost-effective method for the manufacture and distribution of nets to all islands will be sought and islanders will be trained to impregnate their own nets in a safe and effective manner. In addition the acceptability of other synthetic pyrethroids (deltamethrin and lambda-cyhalothrin) will be tried as they have been shown to be more effective than permethrin in other trials.

Initially a pilot area will be chosen and a sociological study ask villagers about their perception of malaria and the use of impregnated bednets, prior to commencing a health education programme. Villagers will be taught the proper use of impregnated bednets and village bednet funds will be promoted, with start-up funding. Various methods of supplying nets will be examined, including bulk purchase from an overseas buyer, central manufacture and distribution through local business outlets, or local manufacture (probably by women's groups).

LSHTM will be involved in an advisory capacity to UKFSP.

TITLE OF PROJECT: Malaria Control and Research Project, Surat. (Rural trial, epidemiology).

COUNTRY: India.

STAFF RESPONSIBLE: Roger Webber, Jo Lines, Shabbar Jaffar, Helen Lambert, Julia Fox-Rushby.

OVERSEAS COLLABORATORS: Shyam Misra and Dr Bhatia (PhD students), NMEP, Gujarat State Health Services, Department of Preventive and Social Medicine, South Gujarat University, the British Council.

FUNDING: DFID - Indian Government

DURATION: 1995 - 2000

SUMMARY:

Gujarat is one of the most malarious states in India, with Surat district responsible for much of the malaria within the state. Also the district has a representative profile of much of India, with a tribal population in the interior, irrigated plains, industrial coastal area attracting migrant labour and a municipality with urban malaria. It therefore is a very good model for trying out different control strategies which might be applicable to much of the rest of the country.

Two interventions are to be tried in the three rural areas:
- Deltamethrin residual spray one cycle
- Deltamethrin treated mosquito nets one cycle
- Comparison area with early case detection and treatment

90607 people in the three areas are under twice weekly suveillance. Intervention villages were chosen by lottery. As well as surveillance annual mass blood surveys are conducted in September.

Preliminary incidence results indicate a 28.43% reduction of malaria due to residual spraying and 52.75% by ITMN when compared with the early case detection and treatment area. The mass blood surveys found a reduction in prevalence of 26.24% and 57.30% with residual spraying and ITMN respectively.

TITLE OF PROJECT: - Control of malaria during pregnancy: an evaluation of the effectiveness of chemoprophylaxis and impregnated bednets.

COUNTRY: India.

STAFF RESPONSIBLE: Daniel Chandramohan & Brian Greenwood.

OVERSEAS COLLABORATORS: Dr V P Sharma & Dr R S Sharma
National Malaria Eradication Programme and Malaria Research Centre, India

FUNDING: Proposal pending

DURATION: 1998-2000

SUMMARY:

Several studies carried out in Africa, where *Plasmodium falciparum* infection is highly endemic, have shown that the incidence of malaria increases significantly during pregnancy and that a substantial reduction in the prevalence of peripheral parasitaemia at delivery, and a moderate increase in mean packed cell volume and birth weight can be achieved by chemoprophylaxis, particularly among primigravidae. Although the efficacy of chemoprophylaxis during pregnancy has been studied in several settings in Africa, no such studies have yet been reported from India. Since the epidemiology of malaria and the health care system in India differ from Africa it may not be appropriate to extrapolate the results of the studies done in Africa to Indian settings. This study aims to evaluate the use of chemoprophylaxis and impregnated bednets to reduce the adverse outcomes of malaria during pregnancy among Indian population.

The following are the specific objectives of the study: (1) to assess the point prevalence of asymptomatic and symptomatic peripheral parasitaemia and parasite density among non pregnant and pregnant women resident in an area of high endemicity during the high transmission season; (2) to assess the cumulative incidence of malaria during pregnancy among primigravidae and multigravidae; (3) to assess the magnitude of risk of low birth weight and maternal anaemia associated with malaria; (4) to estimate the population attributable risk (preventable fraction) of low birth weight and maternal anaemia associated with malaria; (5) to assess the acceptability of chemoprophylaxis among pregnant women; (6) to evaluate the efficacy and cost effectiveness of chemoprophylaxis with chloroquine compared to impregnated bednets.

This work will help to identify an appropriate intervention to control malaria during pregnancy in India. It will also improve our understanding of the effects of chemoprophylaxis and impregnated bednets on plasmodium vivax malaria during pregnancy. This project proposal will be submitted for funding in May.

TITLE OF PROJECT: Urban Surat: Social Marketing of ITMN

COUNTRY: India

STAFF RESPONSIBLE: Roger Webber, Caroline Jones, Jo Lines, Daniel Chandramohan & David Bradley

OVERSEAS COLLABORATORS: Dept. Social and Preventive Medicine (PSM), Surat. Centre for Social Studies

FUNDING: DFID

DURATION: 1997 - 2000

SUMMARY:

It is now widely recognised that the use of impregnated bednets can reduce mortality and morbidity from malaria by between 17% and 63% in Africa. However, while impregnated bednet programmes have been implemented successfully in many areas of China and southeast Asia, as well as in some parts of rural India, the strategies required for successful implementation in urban India have not yet been investigated. The aim of the Malaria Control and Research Project in Surat is to reduce malaria disease and death by developing an effective and affordable malaria control programme in the Surat District and Municipality. In view of the success of impregnated bednets in other areas, the Surat project is including an urban bednet trial investigating the health benefits, acceptability and sustainability of the intervention. The urban bednet trial is part of an inter-linked series of projects and will include a study of the epidemiological, entomological, sociological and economic aspects of bednet use. The aims of this component of the project are:

To record baseline health information in the project area.
To investigate local concepts about the origins and nature of malaria and fever, as well as current preventive strategies and the priority that householders give to malaria prevention.
To monitor the acceptance and utilisation of bednets in the study area and to investigate perceptions of the role of individuals, community and government in the control and prevention of malaria (including the provision of bednets).
To assess the impact of bednet utilisation on the malaria problem of the study area.
To assess the cost implications and sustainability of the intervention.

The project is being conducted in collaboration with the PSM, Surat who will identify a local NGO to act as the agents for bednet distribution. Collection of sociological data in the three urban areas of the trial has begun.

TITLE OF PROJECT: Effects of irrigated rice agroecosystems on the amount of malaria and schistosomiasis in West Africa.

COUNTRIES: Mali, Cote d'Ivoire.

STAFF RESPONSIBLE: David Bradley, Jo Lines (David Bradley is Chairman of the Scientific Advisory Committee).

OVERSEAS COLLABORATORS: Prof. Yeya Toure, Dr Mamadou Traore
Dr T. Teuscher, Dr P. Matlon, Dr Pierrer Carnevale
West African Rice Development Association
4 other organizations in Mali and Ivory Coast

FUNDING: IDRC, Noraid, WHO

DURATION: 1995-1999

SUMMARY:

95% of the potential for irrigated rice cultivation in West Africa is unexploited, yet rice consumption there is rising by 11.5% annually. Irrigation is said to be associated with increases in malaria and schistosomiasis but the effect on malaria, in particular, is not well substantiated and there is also counter-intuitive evidence of a fall in malaria. This large ($3m) study seeks, by both intensive and extensive studies, to determine the effect of irrigating rice and also to work out the optimal management of these agroecosystems for maximum production and good health.

The malaria component in Mali compares malaria incidence in 3 sites outside the irrigation area with 3 sites inside. The current data shows greater transmission outside and no evidence at all of an increase due to irrigation. The more widely spread study in Cote d'Ivoire has been redesigned in 1996 to link more closely to agro-economic zones.

In 1996-1997 good progress was made in Mali and it was confirmed that irrigated rice development does not make the malaria problem worse. A much wider observational study in Cote d'Ivoire now seeks to relate multiple agronomic aspects of rice cultivation to several measures of malaria transmission. Good quality data are being colleted, but it is too early to see any patterns in the results so far. This part of the study is well integrated with the rice farming organizations.

28 February 1998 - The Cote d'Ivoire component is now making excellent progress under Dr Pierre Carnevale and extensive surveys have been carried out, with follow-up throughout the year.

TITLE OF PROJECT: Interannual temperature variability and malaria in the Andes and East Africa. Associations with El Niño, and applications for epidemic forecasting.

COUNTRIES: 1.East Africa (highland fringes e.g. Madagascar & Ethiopia).
2. North coast of South America: Venezuela & Colombia.

STAFF RESPONSIBLE: Menno Bouma, Jon Cox, David Bradley.

OVERSEAS COLLABORATORS: Assefa Tulu, Malaria Control Programme, Ethiopia
William Rojas, C.I.B. Medillin, Colombia
Jonathan Patz, Johns Hopkins, Baltimore, USA

FUNDING: DFID. EPRI

DURATION: April 1998 - April 1999

SUMMARY:
Historically malaria epidemics occurred in areas with unstable malaria, where the population with limited immunity was particularly vulnerable to serious morbidity and mortality. In certain parts of Asia, Africa and the Americas epidemics tended to recur with regular intervals of between 4 and 8 years. With the introduction of mass spraying campaigns in the 50s and 60s most of the areas in which epidemics occurred were freed from malaria. However, in recent decades the reliance of malaria control on insecticides has decreased (resistance and costs), a trend that has been accompanied by the re-occurrence of epidemic malaria. Therefore, the need to develop early warning systems that allow preparedness (drug supplies, vector control) has been identified in the new global strategy for malaria control, outlined by WHO. Recently a striking worldwide relations has been noticed between areas where periodic malaria epidemics occurred and areas where the El Niño Southern Oscillation (ENSO), an atmospheric-oceanographic weather system in the Pacific, affects rainfall and temperature.
Using the El Niño forecasts, weather anomalies in these areas can now be predicted at least 6 moths in advance, and may thus provide a lead to investigate early warning systems for malaria epidemics in these areas. Research in the last years has shown that ENSO malaria forecasting can be applied in India (Rajasthan) and Venezuela.
The current project will investigate the possibility to develop an appropriate model for highland fringe malaria early warning systems for the epidemic prone highland areas in Africa and S. America.
1) Analysis of historical malaria data in relation to climate variables in E.Africa (Ethiopia & Madagascar) and Colombia and Venezuela. This will provide information on the strength of the relations between climate variables, malaria and the ENSO.
2) Analysis of recent epidemics in relation to climate variables and the ENSO.
3) Identify high and low risk years and altitudes for malaria epidemics, which would improve epidemic preparedness.
4) Apply Remote Sensing techniques and Geographical Information Systems to monitor environmental variables predicted by ENSO and to obtain spatial information on the distribution of the risk factors.

TITLE OF PROJECT: The potential for epidemic forecasting and containment of irrigation related malaria in Gujarat, India

COUNTRIES: India

STAFF RESPONSIBLE: Menno Bouma, Jon Cox, David Bradley

OVERSEAS COLLABORATORS: V.P. Sharma (MRC, Delhi)
S.Lal (NMEP, Delhi)

FUNDING: DFID Programme (Phase 1)
World Bank
DFID for Phase 2

DURATION: (Phase 1) April–September 1996 completed
(Phase 2) 1998–2000

SUMMARY:

Malaria has re-emerged as a major health problem in India, with an estimated 141 million people now living in epidemic prone areas. Research to investigate the possibilities of epidemic forecasting is urgently required.

This project will identify risk factors for malaria related to rainfall and irrigation in Gujarat and develop techniques for predicting and monitoring environmental factors. Protocols for the effective use of this information in malaria control programmes will also be developed. In non-irrigated areas prediction and monitoring of rainfall is likely to improve epidemic preparedness, thus reducing morbidity and mortality, and improving the cost-effectiveness of control operations. In irrigated areas, where malaria is more endemic, identification of risk factors may provide information such as how to avoid agricultural, irrigation and settlement practices associated with malaria transmission.

Objectives

1 Establish epidemiological relations between recorded malaria at PHC level and environmental variables relevant to malaria transmission (data: monthly malaria data; irrigation data (type, discharge, water use/cropping patterns); climate data (including gridded databases); El Niño/ sea surface temperature data; satellite imagery).

2 Use these relations to identify risk factors for epidemic and endemic malaria.

3 Predict risk factors for malaria, such as rainfall and irrigation development.

4 Monitor risk factors for malaria and issue early warning at state, district and PHC level.

5 Develop decision making protocols for health planners to ensure sustainability of the developed expertise.

TITLE OF PROJECT: Remote sensing in Malaria Epidemiology.

COUNTRIES: Brazil.

STAFF RESPONSIBLE: David Bradley.

OVERSEAS COLLABORATORS: Gustavo Bretas.

FUNDING: IDRC & TDR

DURATION: - 1994-9

SUMMARY:

The Amazonas region of Brazil is highly endemic for chloroquine-resistant falciparum malaria. It is transmitted by Anopheles darlingi within the rain forest and near to the forest edge. Malaria control has mainly been by case management, and mobile workers from the malaria control programme seek out the ill. Data from blood slides are recorded and, in the settled forest edges, the data are analysed for each kilometre square. The rate of settlement and of deforestation has been high in Rondonia province, which has a massive public health problem.

Dr Gustavo Bretas, a physician supported by the Brazilian government, is studying epidemiology with us and has developed a strong interest in remote sensing and geographical information systems. High resolution pictures gathered by the French 'Spot' satellite provide detailed and up-to-date data on the forest limits and settlement. This is combined in a GIS with data from the malaria service and with survey data gathered by Gustavo Bretas using a global positioning device to fix the households studied on the map.

Funding was obtained from IDRC for the main study which began in June 1993. WHO/TDR provided funds for pilot studies which showed that malaria was heterogeneous even at the forest edge. We were able to show that microtopography is an important determinant, as low lying land near water-courses becomes flooded and provides breeding habitats for *An.darlingi.*

A draft thesis has now been prepared and this project should be finalized in the coming year.

TITLE OF PROJECT: Modelling of the consequences of global climatic change for malaria endemicity: alternative approaches.

COUNTRIES: Initially Europe, Asia, UK.

STAFF RESPONSIBLE: David Bradley, Tony McMichael, Menno Bouma.

OVERSEAS COLLABORATORS: Dr Katy Sinka (currently University of East Anglia) is developing the project.

FUNDING: Sought from EC Environment Programme. Decision expected after June 1996.

DURATION: Hopefully 1996-1999

SUMMARY:

(Proposal under development)

There are now several models of human malaria transmission on a global scale as a function of temperature. They have tended to suggest a vast extension of the areas of potential malaria transmission, which is of limited utility because of its manifest unreality.

We are exploring alternative ways of tackling the problem, such as by the selection of analogous sites today with the climatic features that would occur at the study site after global warming. There may be other different approaches and Dr Sinka is exploring these.

In 1996-97 this was developed into a comprehensive collaborative proposal with colleagues in Maastricht University, Wageningen University and the Universities of East Anglia and of Dublin. This has been submitted to the European Community environmental programme for funding. Competition is very great (some 1500 applications) and decisions should be made in the summer of 1997.

28 February 1998 - The EU did not fund this collaborative study and Dr Sinka has now taken up a post with CDSC. The UK component of the study will be revived when an appropriate research student becomes available.

TITLE OF PROJECT: Determinants of Malaria Transmission in the Highlands of Ethiopia: the Impact of Global Warming on Morbidity and Mortality Ascribed to Malaria.

COUNTRY: Ethiopia.

STAFF RESPONSIBLE: Roger Webber, David Bradley, Jo Schellenberg.

OVERSEAS COLLABORATORS: Dr Assefa Tulu PhD, National Organisation for the Control of Malaria and Other Vector Borne Diseases.

FUNDING: WHO/TDR

DURATION: 1991 - 1996

SUMMARY:

A study was undertaken in Debre Zeit to identify the most important determinants of malaria transmission and whether climate change, possibly brought about by global warming, was responsible for the increased malaria in recent years in the highlands of Ethiopia.

There was a 67fold increase in morbidity and 13 fold increase in mortality from malaria within the last two decades, while highland communities living between 2000 and 2200 m were affected by P.falciparum for the first time since 1986. This coincided with an increase in both daytime and night-time temperature, particularly since 1988. Each ^{0}C rise in monthly mean night-time temperature was associated with a 60% rise in the monthly incidence of P.falciparum. Areas that were subject to epidemics changed to a pattern of perennial transmission and higher altitudinal levels experienced epidemics for the first time. Epidemics of malaria, especially the one in 1958, which claimed 150,000 lives, were found to be associated with El Nino southern oscillations which cause a major change in world climate with an influence as far as Ethiopia.

Other reasons for an increase in malaria were explored, such as the reduced use of DDT residual spraying, an increase in chloroquine resistant falciparum malaria and population migrations. They all contributed to the increased level of malaria, but could not explain the coincident change with temperature and the increase at high altitudinal levels in stable populations where vector control methods had not been used.

From these findings it was concluded that there had been an increase in malaria, both to a higher altitudinal level and in the frequency of epidemics, associated with a rise in night-time temperature. The rise in night-time temperature was due to climatic change which was consistent with studies in other parts of the world, suggesting that global warming was responsible. PhD has been completed, one published paper and others are in press.

TITLE OF PROJECT: Microclimate and temperature variability: implications for the extrinsic cycle of the malaria parasites.

COUNTRIES: Ethiopia.

STAFF RESPONSIBLE: Jon Cox, Menno Bouma, David Bradley

OVERSEAS COLLABORATORS: Assefa Nega Tulu.

FUNDING: DFID Programme.

DURATION: May 1996 - June 1998

SUMMARY:

The increase in mean temperature in highland areas in malarious countries is related to more malaria epidemics in Ethiopia, Rwanda, Kenya and elsewhere. Work in Ethiopia shows a greater effect of rises in the minima than in the maxima. This has led to this project which is concerned with the epidemiology and prediction of malaria increases.

This field project examines diurnal temperature regimes at Debre Zeit, Ethiopia, the focus of other research efforts in the Programme. Indoor and outdoor temperatures are being monitored continuously using electronic thermistor probes and a data logger. Over a year of data, from 10 probes recording at 30 minute intervals has now been recorded. These show significant variation in temperature profiles between different hut types, and between indoor and outdoor probes.

Existing long data sets for minimum and maximum temperatures will be combined with the curves of diurnal temperature change to develop a measure of degrees above the critical level per unit of time. This will be used in a model of the Ethiopian situation to assess the relative roles of change in maximum and minimum temperatures upon the levels of malaria transmission. In addition, the range of estimates of vectorial capacity, estimated using conventional meteorological data as well as our own data relating to specific mosquito habitats will be assessed. This is important for evaluating the possible limitation of current predictive models of malaria distribution and climate change, where standard equations to calculate the length of the extrinsic cycle based on mean temperature are used. This phase of work will be completed by June 1998.

TITLE OF PROJECT: Malaria control and wise use of wetlands.

COUNTRIES: Zambia, Zimbabwe, Malawi.

STAFF RESPONSIBLE: David Bradley, Daniel Chandramohan.

OVERSEAS COLLABORATORS: PEEM, Geneva.
IUCN, Morges and Harare.
National Governments of countries involved.

FUNDING: Proposal for PEEM, CIDA.

DURATION: 1996 -

SUMMARY:

The prevention of malaria has often been achieved by draining wetlands to remove the anopheline breeding places. More generally, public health engineering has proceeded by the ever sharper separation of land and water. But the conservation movement has drawn attention to the need to preserve wetlands. The needs of conservation and of public health therefore tend to be opposed, though there has been little explicit discussion of this issue.

For some years we have sought appropriate opportunities for investigation of this problem. The IUCN now proposes to undertake work on the 'wise use' of wetlands in four countries of the Zambezi Valley in southern Africa. In collaboration with PEEM we are exploring the possibility of adding a health component to studies in two of these countries to determine how to minimize disease (and particularly water-related disease, such as malaria) consequences for the populations of conserved wetlands.

Feasibility study was completed in May/June 1996. Since no epidemiological research question specific to wetlands were identified this project was not pursued further.

The report on this feasibility study has been completed and was well received by PEEM. We considered there was a limited case for a comprehensive research project although several specific items (mostly outside malaria) for research were identified. An approach by PEEM to the Dutch government was made, but funds have not been forthcoming. The feasibility report will be of substantial value to the Canadian project for conservation work in the area.

In view of the limited research questions on malaria specifically, our contribution to the work is viewed as closed from December 1997.

TITLE OF PROJECT: Global positioning system (GPS) - Assisted exploration of factors influencing the spatial distribution of malaria cases by household in the study area of the Bo malaria project, Sierra Leone.

COUNTRIES: Sierra Leone.

STAFF RESPONSIBLE: Nuahn T. Marbiah (Research Fellow/THEU)

OVERSEAS COLLABORATORS:

FUNDING: EC Grant TS3-CT93-0251.

DURATION: November 1995 - June 1996.

SUMMARY:

Preliminary analysis of data from a recently completed randomised controlled trial investigating the impact of community-wide use of insecticide impregnated mosquito nets on clinical malaria in children indicated a higher-than-expected or aggregation of cases in inhabitants of certain households in the study area. This phenomena probably indicate differences in malaria risk by households within the specific community. As the conventional wisdom on the allocation of sampling unit in anti-malaria interventions (with possible community-wide impact) is based on the premise of a uniform malaria risk within the communities to be allocated, a differential risk in a group of sub-units (households) within such communities could have important implications for the choice of a sampling frame (household versus community) and therefore the cost of a trial. Such differences in the malaria risk at the household level within a community randomised to intervention or control arm of a trial may possibly lead to serious error in assessment of the impact of the intervention, as the comparison between the intervention and control arm of the trial is based on a summary of the impact in the constituent households in the community. If these households have differences in their risk of malaria to start with, then summarizing the effect of the intervention over these households is inappropriate and probably indicate that the estimate of effectiveness derived for our study based on this approximation is probably an underestimate of the true impact.

The GPS data gathered in this study is intended to assist with estimating the risk of malaria in individual households in the study communities by exploring for the various factors that are known to influence such risks; ease of mosquito assess into the households, use of protective anti-malarial measured, distance from breeding sites etc. A comparison of the summary of malaria risk in a community versus that in individual households within that community should be instructive in assessing the choice of a sampling unit in similar study. If this hypothesis is confirmed by this analysis and repeated during future investigations, it would have implications for the design of anti-malarial interventions.

TITLE OF PROJECT: MALARIA AMONG YANOMAMI AND YEKWANA ETHNIC GROUPS: A STUDY IN THE VENEZUELAN AMAZON

COUNTRY: Venezuela

STAFF RESPONSIBLE: Adriana Tami (PhD student), Roger Webber, David Warhurst, Maria Quigley

OVERSEAS COLLABORATORS: Dirección de Endemias Rurales, Malariología y Saneamiento Ambiental, M.S.A.S., Venezuela. Institute of Tropical Medicine, Universidad Central de Venezuela, Caracas, Venezuela.

FUNDING: The British Council. Consejo Nacional de Investigaciones Científicas y Tecnológicas (CONICIT), Venezuela. Fundación "Gran Mariscal de Ayacucho" (FUNDAYACUCHO), Venezuela.

SUMMARY:

Malaria poses a considerable health threat to the indigenous populations of the Venezuelan Amazon but, so far very little research has been carried out on the malaria situation there. One of the most affected areas is the Upper Orinoco River where two ethnic groups, the Yanomami and the Yekwana, coexist in relative isolation. Malaria is difficult to control in this forest area with limited access compounded by the semi-nomadic nature of the inhabitants dispersed in small hamlets. The main vector, *Anopheles darlingi,* presents intense exophilism. Recent observations have suggested the emergence of drug resistant falciparum malaria. There is a recognised need to understand the epidemiology of malaria in order to improve control measures. In view of the above, the aims of this project are to describe the basic epidemiological features of malaria, to assess the presence of genetic polymorphisms putatively associated with drug resistance, and to characterise the antigenic diversity of *Plasmodium falciparum* infecting these populations.

Ten villages along the Padamo River (a tributary of the Orinoco), 7 Yanomami (405 people) and 3 Yekwana (303 people), have been surveyed during Nov'95-Feb'96. A detailed census was conducted, household survey and a questionnaire on demographic data and risk factors completed. Blood and urine specimens were taken and a clinical examination made of everyone in these two ethnic groups. A WHO 7-day *in vivo* chloroquine resistance (CQR) test was applied to *P. falciparum* cases. Specimens were later analysed in the laboratory.

Three main outcomes were derived: **1) *Malaria impact differs by ethnic group***. Yanomami are the most affected with parasite (16%) and splenomegaly (50%) rates significatively higher than the Yekwana (8% and 10% respectively) as well as with prevalence of anaemia and antimalarial antibodies.
2) *Homogenous Pfmdr1 genotype in relation to clinical chloroquine resistance.* Sixteen out of 40 *P. falciparum* infections were evaluated for CQR *in vivo* showing 50% resistance at the RI and RIII level. DNA from the 40 fresh isolates was examined by PCR-RFLP of the *Pfmdr1* gene (codons 86, 1042 and 1246) putatively associated with CQR. In spite of the *in vivo* findings, a 100% prevalence of the Asp-1042 and Tyr-1246 alleles was demonstrated. The Tyr-86 allele was not detected in any isolate.
3) *Restricted P. falciparum diversity*. The homogeneity of the *Pfmdr1* polymorphisms was mirrored in the low diversity of the parasites, as determined by PCR genotyping of MSP-1, MSP-2 and GLURP. For each of the three polymorphic markers, the same single allelic variant was observed in 33/39 of the cases, implying infection by one homogeneous genotype. This is a unique finding in contrast to the high diversity reported from other parts of the world.

The above findings raised questions that motivated a second phase of fieldwork that has recently been completed. Around 1000 people from the same villages were studied and blood samples collected. Molecular epidemiological analysis of the data is in progress and will be compared to the data of the first field work.

TITLE OF PROJECT: Evaluation of a new surveillance strategy for low level malaria.

COUNTY: China

STAFF RESPONSIBLE: Roger Webber

OVERSEAS COLLABORATORS: Dr Shen Jie, Ministry of Public Health, Beijing. Profs. Zhang Shaoqing, Xu Bozhao and Cheng Feng, Institute of Parasitic Diseases, Hubei.

FUNDING: WHO/TDR

DURATION: 1995 - 1996

SUMMARY:
China has been very successful in the control of malaria with a prevalence of less than one per ten thousand in many areas. However the system of surveillance is still based on taking blood slides from all cases of fever or with a common cold, resulting in a very large number of negatives. This is inefficient, expensive and likely to lead to mis-diagnosis, and a more efficient and cost-effective method needs to be found.

Hubei Province has been chosen as the trial area with detailed studies in Jiang Ling and Xiantao, as well as analysis of all blood slides collected throughout the province. All blood slides collected are divided into five groups:

- diagnosed as clinical malaria (group 1)
- suspected as malaria (group 2)
- fever only (group 3)
- common cold (group 4)

In the low prevalence area (0.23%) group 3 detected 5/10000 cases and group 4 2/10000 cases and it is recommended that these categories be dropped from low prevalence areas to encourage greater efficiency in detecting cases in the clinical and suspected malaria categories (groups 1 and 2). In the moderate area with a prevalence of 4.19% all categories, including common cold (group 4) were considered valuable to detect malaria cases.

TITLE OF PROJECT: Historical analysis of malaria policy.

COUNTRY: Global.

STAFF RESPONSIBLE: David Bradley.

OVERSEAS COLLABORATORS: Prof B. Fantini, University of Geneva.

FUNDING: None.

DURATION: 1995-1996.

SUMMARY:

Policy in malaria control is, perhaps more than for any other disease, the prisoner of its history. Whilst the epidemiology of malaria is complex but relatively well understood and logical, control policy has changed radically several times in the last half-century, driven by scientific advances and health goals, but administrative structures have often been more appropriate to past activities. In the last three years substantial historical research effort has been devoted to understanding the processes at work, and we have become increasingly involved.

Work has been completed on the development of the concept of species sanitation at the beginning of the 20th century, an area of current interest in relation to rapid environmental change and the use of environmental control.

Work on the sequence of dichotomous conflicts in malaria policy: general/specific; control/eradication; horizontal/vertical and disease-specific/primary health care has led to a draft paper discussed at a recent meeting. It seeks to dissect out different conflicts, to show why they became confused together, and to liberate thinking from these past over-simplifications.

The first has been published, the second is in the press at present. A third phase is planned for 1998 in relation to specific control policies.

In addition the Ross centenary is leading to several analyses of Ross's many contributions to malaria and is being used as a springboard to help revive public health in India.

28 February 1998 - The third phase will now look at the history of environmental control of malaria and a paper is under preparation for the meeting in May 1998.

TITLE OF PROJECT:	A trial of treated nets against malaria in the Upper Orinoco
COUNTRY:	Venezuela
STAFF RESPONSIBLE:	Magda Magris (PhD student), Jo Lines
OVERSEAS COLLABORATORS:	CAICET, Venezuela
FUNDING:	Venezuelan Government
DURATION:	1997-2000

SUMMARY:

The trial will take place in two fixed mission settlements and their satellite communities, most of the residents being Yanomami people. Mosquito nets have already been given to these communities; the trial will test the additional effect of insecticidal net treatment. Households will be randomised into two groups, one to be treated with pyrethroid insecticide and one to be treated with a placebo. Outcome measures will include the incidence of clinical malaria and the prevalence of parasitaemia, splenomegaly and anaemia in mass surveys.

Intervention is planned for the start of the 1998 transmission season.

TITLE OF PROJECT:	Development of an ELISA for measuring pyrethroid deposits on mosquito nets.
COUNTRY:	UK (Collaboration with Salford University)
STAFF RESPONSIBLE:	Edward Magbity (PhD student), Jo Lines
OVERSEAS COLLABORATORS:	None
FUNDING:	DFID
DURATION:	1 year

SUMMARY:

The aim is a test that can be used for quality control in monitoring systems of net treatment. At present only Gas Chromatography (GC) can be used for this. GC is expensive and sophisticated: only a few samples can be analysed from any one project and it takes months to return the results. Antibodies against pyrethroids have been made and used in ELISA tests to measure environmental contamination; this project will adapt the same techniques for use with nets.

TITLE OF PROJECT: Risk assessment of pyrethroid exposure through net treatment and use of treated nets.

COUNTRY: UK

STAFF RESPONSIBLE: Jo Lines

OVERSEAS COLLABORATORS: DFID-funded social marketing project in Tanzania

FUNDING: Possibly DFID

DURATION: 1 month

SUMMARY:

No independent hazard classification and risk assessment of the technology of net treatment has taken place since 1989. Since then, new approaches to net treatment and new toxicological evidence have appeared. Funding has recently been approved to commission such a study. It will be carried out as part of a DFID-funded project aimed at exploring strategies for the social marketing of nets and net treatment in Tanzania. This project will be executed by PSI (Population Services International), who have much experience in the social marketing of contraceptives. This part of the project aims to review the situation, and to provide an up-to-date overview of chemical safety aspects that can be referred to by projects trying to allay public anxiety about the potential toxic effects of treated nets.

The project has recently been launched, and terms of reference for this element of the work are now being drawn up.

TITLE OF PROJECT: Design of social marketing strategies for nets and net treatment in Tanzania

COUNTRY: Tanzania

STAFF RESPONSIBLE: Jo Lines (via Malaria Consortium)

OVERSEAS COLLABORATORS: Population Services International (PSI)

FUNDING: DFID (Tanzania) via Malaria Consortium

DURATION: 2 years (1 month initial consultancy)

SUMMARY:

The project, which has just been approved, will be implemented by PSI. Its main outputs will be field-tested strategies for social marketing of nets and net treatment in the Tanzanian context. It will be the first treated net implementation project to rely primarily on commercial distribution channels for nets, and on the "dip-it-yourself" approach to insecticide distribution.

The London School of Hygiene and Tropical Medicine, via the Malaria Consortium, has contributed to the design of the project, and will continue to be involved in the project's operational research elements.

TITLE OF STUDY: Cost-effectiveness analysis of malaria control in Surat: Treated mosquito nets vs in-house residual spraying

COUNTRY: India

STAFF RESPONSIBLE: Dr Julia Fox-Rushby

PHD STUDENT: Dr Mrigesh Bhatia (PhD student)

FUNDING: DfID - Indian Government

PROJECT DURATION: 1995 - 2000

SUMMARY:

Malaria control in rural India is primarily based on in-house residual spraying plus early diagnosis and treatment of cases. With malaria re-emerging as a major public health problem in some parts of India, and growing disillusionment with existing malaria control interventions in India, particularly in-house residual spraying there is a need to assess newer innovative strategies for malaria control. With increasing evidence of efficacy of treated mosquito nets from around the world, it was felt necessary to compare this intervention with in-house residual spraying in Surat.

The aim of this study is to undertake an incremental cost-effectiveness analysis of these interventions from a societal viewpoint with the following objectives: i. to determine the total costs of each intervention to the health sector and households; ii. to calculate the resources saved by the health sector and the household by averting malarial morbidity as a result of each of these interventions; iii. to combine data on cost with effectiveness as a measure of efficiency.

The data collection for these studies is currently in progress.

Costing analysis will be combined with efficacy data from Project 19 to produce cost-effectiveness analysis. This is a joint project with the Health Economics Programme.

TITLE OF STUDY: Willingness to pay for malaria control in Surat

COUNTRY: India

STAFF RESPONSIBLE: Dr Julia Fox-Rushby

PHD STUDENT: Dr Mrigesh Bhatia (PhD student)

FUNDING: DfID - Indian Government

PROJECT DURATION: 1995 - 2000

SUMMARY:

The future pattern of malaria control in India is being questioned. There is growing disillusionment with in-house residual spraying and increasing recognition of the cost-effectiveness of controlling malaria with treated mosquito nets (TMNs). Concern for the fact that the government alone is unlikely to be in a position to finance (TMNs) has raised the issue of whether users would be willing to pay for treated mosquito nets and its subsequent re-treatment.

This study aims to provide the willingness to pay (WTP) estimates for treated mosquito nets and their re-treatment, compared with WTP for spraying. The data collection was undertaken using both qualitative and quantitative methods under the broad framework of the theory of demand. In the first stage 25 FGDs and 117 semi-structured interviews were held with key informants. The results from the qualitative study acted as inputs for preparing a valid and reliable WTP survey instrument for the quantitative study undertaken in the second stage. 1200 households were surveyed belonging to different castes and ecological zones from 80 villages to assess the WTP for treated mosquito nets. Preliminary results found that people would be prepared to pay an average Rs 75 (£1.25) to buy a net.

This study is in collaboration with the Health Economics Programme and will provide information for implementation of findings from Project 19.

TITLE OF PROJECT: A trial of the malaria vaccine RTS,S

COUNTRY: The Gambia

STAFF RESPONSIBLE: Brian Greenwood

OVERSEAS COLLABORATORS: Dr Doherty, Dr Bojang and others, MRC Laboratories, The Gambia; Dr Ballou and others, Walter Reed Army Hospital, Washington, USA; Dr Cohen and others, Smithkline Beecham, Rixensaart, Belgium.

FUNDING: EEC (Biotechnology demonstration project)

DURATION: 1997-2000

SUMMARY:

RTS,S is a Plasmodium falciparum sporozoite vaccine based on the expression of the circumsporozoite protein in combination with the Hepatitis B surface antigen in yeast. The vaccine is given with a powerful adjuvant (MPL + QS21) as an oil-in-water emulsion. Six of 7 American military volunteers were protected against mosquito challenge with *P.falciparum* when given three doses of RTS,S over a 6-month period.

The American volunteers successfully protected with RTS,S were challenged with the same strain of parasite used to develop the vaccine. This will not be the case in The Gambia where volunteers will be challenged with a variety of strains of wild parasite. To determine whether the vaccine induces a strain specific immunity, parasites from vaccinated and control subjects will be tested for variation in their CSP proteins using molecular biological techniques. These studies will be done at LSHTM.

During the early part of 1997, 150 adult Gambians resident in Upper River Division were enrolled in an efficacy trial. Two doses of RTS,S or a control vaccine were given without any significant side effects. Unfortunately, shortly before the third dose of vaccine was to be given, it was discovered that the batch of RTS,S prepared for this trial had degraded. Thus, after extensive discussions with the manufacturers and with the DSMB, it was decided to abandon the trial and to repeat the study in 1998. Detailed discussions were held with the trial's volunteers to explain how this situation had come about.

On the basis of information on the incidence of malaria collected in the study area in 1997 the repeat trial will have an increased sample size of 300 adults. They will receive their first dose of RTS,S or control vaccine in February 1998.

TITLE OF PROJECT	Who cares? The public-private mix in malaria service provision in urban India: Towards evidence-based interventions.
COUNTRIES:	India
STAFF RESPONSIBLE:	Caroline Jones, Ruairi Brugha, Anthony Zwi
OVERSEAS COLLABORATORS:	Dr Vikas Desai, PSM, Government Medical College, Surat, India.
FUNDING:	DFID
DURATION:	1997-2000

SUMMARY:

This research aims to evaluate the role and quality of public and private-for profit provision of malaria prevention, treatment and care services in Surat, India and to examine the potential for developing and implementing pilot interventions which seek to enhance the quality of these services. Malaria continues to be a significant public health burden in India despite the considerable investment in control programmes. International health sector reform seeks to widen the base of health service provision and the private-for-profit health sector is widely used in communities throughout India. However, little is known about the quality and range of services that the private-for profit sector provides for malaria and this sector is neither incorporated into nor co-ordinated with national disease control programmes. Phase 1 of the research will identify the range of public and private-for-profit providers of malaria services in urban Surat, explore the utilization of these services, assess the quality of care offered and assess the influences acting on provider behaviour. Phase 2 will use participatory methods to identify the range of policy options which may assist in developing linkages between the public and private sectors with a view to maximising population coverage and access to effective malaria services. Pilot interventions will be identified, implemented in a small number of sites and evaluated; the potential for following this up with a more sustained intervention programme will be considered as a follow-on to the present research.

The range of providers in the five urban study areas have been identified. First and second round interviews have been held with the key stakeholders (e.g. Surat Municipal Corporation, General Practitioners Association etc.) and they are all enthusiastically involved in the project. Interviews and facility assessment of the providers in the study areas have started as have focus group discussions with community members to elicite their views on the quality of service provision.

TITLE OF PROJECT: Effect of placental malaria on vertical transmission of HIV

COUNTRY: Zimbabwe

STAFF RESPONSIBLE: Daniel Chandramohan, Brian Greenwood

OVERSEAS COLLABORATORS: Ruth Lobode, Barbara Ritter, Ministry of Health, Zimbabwe

FUNDING: Proposal Pending. To be submitted to Wellcome or EU?

DURATION: 18 months

SUMMARY:

Several factors such as maternal p24 antigenaemia, low CD4+ lymphocyte count (<29% of total lymphocytes pr<700/µl), intravenous drug use during pregnancy, duration of rupture of membranes >4 hours, vaginal delivery and practices that increase birth canal exposure (eg. episiotomy, scalp electrodes, forceps, vacuum), low birth weight (<2500g), and breast feeding have been shown to be associated with an increased risk of vertical transmission of HIV. Recently from a secondary analysis of data from a trial of chemoprophylaxis during pregnancy suggested that placental malaria may predispose perinatal transmission of HIV. This study aims to confirm the increased risk of perinatal transmission of HIV associated with placental malaria.

This work will contribute to review the policy on chemoprophylaxis during pregnancy. The project proposal will be submitted for funding in May.

TITLE OF PROJECT: Epidemiology of malaria during pregnancy in Indonesia

COUNTRY: Indonesia

STAFF RESPONSIBLE: Daniel Chandramohan, Brian Greenwood

OVERSEAS COLLABORATORS: Iwan Dwiprahasto (PhD student)
Gadjha Mada University, Indonesia

FUNDING: World Bank

DURATION: 1997-1999

SUMMARY:

Several studies in sub-Saharan Africa have shown that malaria during pregnancy is an important determinant of maternal health and perinatal outcomes and that the risk of maternal anaemia and low birth weight can be reduced significantly through chemoprophylaxis, especially among primigravidae. There is, however, very little data from Southeast Asia on the effects of malaria during pregnancy. The epidemiology of malaria during pregnancy in Southeast Asia is different from that of sub-Saharan Africa because the risk of malaria during pregnancy is lower and the access to appropriate treatment of malaria is higher in this region compared to Africa. Hence, results of studies from Africa may not be applicable to Southeast Asia and there is a need to study the effects of malaria during pregnancy in this region.

Data collection for this study started in September 1997 and is expected to be completed in December 1998. This work will contribute to the development and implementation of an appropriate policy on chemoprophylaxis during pregnancy in Southeast Asia.

TITLE OF PROJECT: Evaluation of a Sick Child Algorithm in an Area with Chloroquine Resistance

COUNTRY: Zimbabwe

STAFF RESPONSIBLE: Daniel Chandramohan, Jon Cox, Brian Greenwood

OVERSEAS COLLABORATORS: Ruth Labode, Davis Dhlakama, Ministry of Health, Zimbabwe

FUNDING: Proposal pending. Resubmit to EU or MIM?

DURATION: 3 years

SUMMARY:

WHO and UNICEF are currently promoting an algorithmic approach for managing children presenting to PHCs in developing countries. According to the algorithm, children in high malaria risk areas who have a history of fever, or have an axillary temperature >37.5°C, should be classified as malaria cases and should be referred after giving quinine or treated with the first line antimalarial drug. The same applies in low risk areas, although children with a running nose, measles or other causes of fever are not given antimalarials.

While it is acceptable to prescribe presumptive treatment with a low threshold of suspicion where chloroquine is effective, evidence of parasite resistance in Southern Africa and the consequent need for more effective (and potentially more dangerous) drugs means that the WHO algorithm needs to be revised in situations where the first line drug has been, or will be changed. This is part of a more general need for data on the usefulness of different clinical case definitions of malaria and the implications of false negative diagnosis. This project will focus on the case of Zimbabwe, where despite reported resistance, chloroquine is still the first line drug. A prospective observational study will be conducted in two PHCs (representing high and low malaria endemicity) based on children presenting to the PHC with a history of fever or temperature >37.5°C. The research will seek to answer the following questions:

*What is the prevalence of chloroquine resistance in Zimbabwe and is there a need to change the first line antimalarial drug?
* Is there spatial and/or time clustering of malaria treatment failure and severe malaria?
* What are the predictive values of an hierarchical algorithm to diagnose malaria in high and low risk areas during high and low transmission seasons?
* What is the risk of progression to severe malaria among children classified as having non-specific febrile illness if treated with chloroquine in a high endemic area with chloroquine resistance?
* What is the risk of progression to severe malaria among children classified as having non-specific febrile illness if treated with paracetamol in a low malaria endemic area?
* What is the risk of progression to severe malaria among children classified as having non-severe malaria if treated with chloroquine in an area with chloroquine resistance?

TITLE OF PROJECT: Population structure of *An.gambiae* in South Africa

COUNTRIES: South Africa

STAFF RESPONSIBLE: Cally Roper, Jo Lines

OVERSEAS COLLABORATORS: National Malaria Programme, S.Africa

FUNDING: DFID via HP-ACORD

DURATION: 3 years

SUMMARY:

This project uses new techniques to ask an old question. In the long dry season of Southern Africa, populations of *An. gambiae* appear to retreat to a few widely scattered permanent water holes, whereas in the rains it is everywhere. It has long been speculated that this regular expansion takes place by dispersal from the "local" permanent water hole, and that eliminating those residual populations when they are small and vulnerable could prevent the normal rainy season expansion.

Highly variable "micro-satellite" DNA sequences have been used in other organisms to study population structure and have been identified in *An. gambiae*. These sequences will be used to establish whether the rainy season mosquitoes in one area are indeed more closely related to each other, and to the dry season populations of the local permanent water hole in the previous season, than they are to the mosquito populations around other water holes. Depending on the results, the work will extend to field trials of local dry season control.

TITLE OF PROJECT:	Prediction in China
COUNTRIES:	China
STAFF RESPONSIBLE:	David Bradley, Jon Cox, Roger Webber Luo Dapeng (PhD)
OVERSEAS COLLABORATORS:	Institute for Malaria Research and Control, Yunnan, China
FUNDING:	TDR
DURATION:	1996 - 1999

SUMMARY:

Yunnan is the most malarious Province of China, and chloroquine-resistant falciparum malaria is continuing to increase, partly due to immigration and socio-economic development of the Red River valley for agriculture. The traditional intensive local surveillance systems for malaria are becoming increasingly unreliable. The terrain is very varied and some of it relatively inaccessible. It is felt that the use of satellite images and geographical information systems can lead to an effective surveillance system capable of predicting outbreaks and guiding control measures.

The work is in two stages:

1. Reconnaissance and use of reported data from 2 counties to develop a first model of the determinants of malaria epidemiology.

2. Field studies to produce a detailed predictive model of malaria epidemiology. This will then be tested against a parallel data set to be collected by the Yunnan Institute. The work involves new research, skills transfer and capacity building.

28 February 1998 - The field work and its analysis from stage one has been completed and the protocols for stage two have been set out in full. This stage will require supplementary funding.

TITLE OF PROJECT: Malaria in historical India

COUNTRIES: India

STAFF RESPONSIBLE: Menno Bouma, David Bradley

COLLABORATORS: Dr Colin Butler (MSc Epidemiology)
Dr J. Almeda-Ortega (Spain, Mozambique)
Prof. Tony McMichael

FUNDING: EU and Desk Study

DURATION:

SUMMARY:

This retrospective study aims to improve the understanding of the dynamics of malaria in the Punjab province of formerly British India, an area which probably suffered the most devastating malaria epidemics ever reported. These epidemics (in this partly semi-arid region), recurred every 5 to 7 years and have been associated with above normal monsoon rainfall, and recently with El Niño Southern Oscillation, a climate system which affects interannual variation of rainfall in the Indian subcontinent. However, many questions on the dynamics of malaria, e.g. on the contribution of irrigation, immunity and famine, remain unanswered and may be highly relevant in respect of the recurrence of epidemic malaria in both India and on a global scale. This historical approach may also elucidate some of the current issues on the effects of global climate change on malaria.

The Indian Punjab has been recognised, particularly because of its exceptional good malaria and environmental data, as one of the most important regions for retrospective research.

Malaria variables (fever deaths as a (recognised) surrogate for malaria deaths and spleen rates as a marker of endemicity) will be related to climatic data (including El Niño Southern Oscillation data), population, cattle, grain price, agricultural and irrigation records for the Punjab from 1869 until 1940 (a period unconfounded by insecticide use), together with altitude and less quantitative data for migration, customs, pilgrimages and other factors.

A temporal and spatial regression analysis will be carried out, using computerised statistical packages and geographical information systems.

TITLE OF PROJECT: The Epidemiology of Highland Malaria in Africa

COUNTRIES: Various highland areas in East and Southern Africa

STAFF RESPONSIBLE: Jon Cox, Menno Bouma, David Bradley

OVERSEAS COLLABORATORS: Brian Sharp and David Le Sueur
National Malaria Control Programme, SA Medical Research Council, Durban, South Africa

FUNDING: TDR/IDRC

DURATION: May 1997-May 1998; funding being sought for further two years.

SUMMARY:

Current climatological evidence shows a clear trend of global warming over recent decades, and while there is still much uncertainty over future predictions of rainfall, it seems clear that environmental temperatures are set to rise further. The impact of climate change on malaria is therefore likely to be most marked in regions where temperature is the principal limiting factor for transmission. In Africa these 'fringe' areas constitute high altitude or latitude areas, and the aim of this research is to explore in more detail the changing epidemiology of malaria in the highland fringes. The analysis will focus on the changing temporal and spatial distribution of malaria transmission in the highland fringe, and will attempt to evaluate the relative contributions of climatological and non-climatological (e.g. land use change) risk factors.

The project consists of three phases. The first has included a rapid delineation of malaria risk at the continental scale based on GIS coverages for rainfall and temperature. The second phase has focused on the identified susceptible area for each highland country, and will collate all available malaria data for the respective regions, as well as data on environmental and social risk factors (thereby testing the reliability of the initial stratification). Technical report will be submitted to TDR in June 1998.

From June planning will begin for a third phase of work, incorporating multi-country prospective studies within the delineated risk zone. Funding for a workshop to formulate a protocol for this work has been provided by TDR.

TITLE OF PROJECT: Mathematical models of the immunological and clinical epidemiology of Plasmodium falciparum malaria.

COUNTRY: UK

STAFF RESPONSIBLE: Brian Greenwood

OVERSEAS COLLABORATORS: Professor Dietz, University of Tubingen (project coordinator)

FUNDING: EEC

DURATION: 1997-2000

SUMMARY:

Prof. Dietz has been supported by the EEC to construct new mathematical models of the epidemiology of Plasmodium falciparum malaria taking into account new knowledge on the immunology of the infection and the effects of parasite diversity. The development of such models may help in the design and conduct of new intervention studies including vaccine trials.

Scientists in several parts of Africa and in Papua New Guinea have agreed to contribute data sets under their control and to collaborate with Prof. Dietz by providing advice based on experience in the field. A series of seminars will be held to discuss the models as they develop. The first meeting of the group will be held in Tubingen in February 1998.

TITLE OF PROJECT: A comparative trial of bednets impregnated with alphacypermethrin or lambdacyhalothrin at Muheza, Tanzania.

COUNTRY: Tanzania

STAFF RESPONSIBLE: Chris Curtis and Brian Greenwood

OVERSEAS COLLABORATORS: Dr Caroline Maxwell, Muheza, Tanzania.

FUNDING: Cyanamid International/WHO

DURATION: 1997-1998

SUMMARY:

A comparative trial is being undertaken in 4 villages, each comprising 3 hamlets, in the Muheza area of Tanzania of bednets treated with alphacypermethrin at a concentration of 20mg/m^2 and bednets treated with lambdacyhalothrin at a concentration of 40mg/m^2. Treatment of nets with alphacypermethrin at this concentration is cheaper than treatment with either lambdacyhalothrin or permethrin.

The efficacy of treated nets will be assessed by the collection of mosquitoes in rooms where treated nets are used and in sentinel houses using lights traps. Side effects questionnaires were administered one week and three months after treatment. Bioassays are being done at regular intervals on treated nets.

The clinical efficacy of nets treated with alphacypermethrin have been determined by measuring the rate at which children aged 1-4 years become re-infected after parasitaemia has been cleared by treatment with a chlorproguanil/dapsone combination.

Preliminary results have shown that bednets treated with alphacypermethrin have been as effective at preventing malaria in children as those treated with lambdacyhalothrin.

TITLE OF PROJECT:	Design of strategies to incorporate treated nets into the National Malaria Control Programme in India.
COUNTRY:	India
STAFF RESPONSIBLE:	Jo Lines
OVERSEAS COLLABORATORS:	NMEP, India
FUNDING:	DFID
DURATION:	-

SUMMARY:

The World Bank is planning substantial support to the NMEP and is pressing for a major shift away from house-spraying to treated nets as the main preventive measure. At one stage, DFID (then the ODA) had plans to contribute to this by providing expertise on treated net implementation strategies. We helped, via the Malaria Consortium, to identify basic strategies and research needs, and hoped to continue to develop these further as the project moved from the design to the implementation phase. This work was not taken further, largely because of administrative problems - an apparent mismatch between DFID/India and World Bank timetables for project development and funding.

TITLE OF PROJECT:	Economic evaluation of malaria control in Africa.
COUNTRY:	Africa
STAFF RESPONSIBLE:	Prof. Anne Mills, Paul Coleman, Catherine Goodman
OVERSEAS COLLABORATORS:	Dr. Reginald Chima, University of Nigeria, Nsukka
Funders:	World Bank through WHO/TDR

Summary:
There are currently no satisfactory and up-to-date reviews either of the cost-effectiveness of interventions for malaria prevention and treatment in Africa, or of the potential benefits of malaria control. Existing studies of economic impact are severely flawed or concern very specific geographical areas, and do not address the question of the extent to which the economic burden would be averted by control measures. Recent advances in control measures (eg insecticide-treated mosquito nets) have yet to be fully evaluated for their cost-effectiveness in different circumstances. And most importantly, existing reviews are largely global, yet most malaria in Africa is very different from malaria in other continents, making it unwise to extrapolate to Africa from studies done elsewhere.

The aims of this study are to:

- calculate the cost-effectiveness of the main tools for malaria prevention and treatment, and measure the sensitivity of cost-effectiveness ratios to changes in key assumptions
- assess the likely economic benefits to be gained from malaria control, for households and Africa as a whole, in terms primarily of reductions in direct and indirect costs
- analyse the cost and benefits of alternative levels and types of investment in malaria control.

The scarcity of data for several of the interventions restricts detailed cost-effectiveness analysis to a subset of the control measures, namely improvement of case management, chemoprophylaxis for pregnant woman, chemoprophylaxis for children, insecticide treated nets, and residual spraying. Rather than concentrating on case studies specific to certain countries, the analysis will provide general results for broadly defined transmission zones: "high risk, low risk", and three economic strata based on per capita income. The effectiveness of each intervention is modelled using a hypothetical population based on a model life table, and calculated in terms of Disability Adjusted Life Years (DALYs). This data is combined with information on costs to produce a likely range for the "Cost per DALY" of each intervention. A societal perspective is adopted, looking at the costs to both government and households.

In addition to the work on cost-effectiveness, information is being reviewed on the costs of malaria, covering both expenditure on treatment and prevention, and the impact of malaria on productivity.

TITLE OF PROJECT: Field trial on the acceptability and efficacy of the K-O Tab for the insecticide treatment of mosquito nets.

COUNTRIES: Tanzania

STAFF RESPONSIBLE: Caroline Jones, Janee Miller.

OVERSEAS COLLABORATORS: Romanus Mtunge, Temeke District Hospital, Dar es Salaam, John Bwana, Adult Mortality and Morbidity Project, Muhimbili Hospital, Dar es Salaam.

FUNDING: AgrEvo

DURATION: September 1997 - December 1997

SUMMARY:

There is great interest among researchers, aid agencies, donors and most importantly among communities themselves in the home treatment of mosquito nets with insecticide for malaria control. Several pyrethroids are now available as liquid formulations that can be packaged in individual sachets or plastic bottles for use in home treatment kits. AgrEvo has recently developed a deltamethrin tablet for treating mosquito nets. The 1.6g tablet is made of freeze dried suspension concentrate (SC) and should deliver a target dose of 25mg a.i/m^2. A trial of this new tablet was carried out in urban Tanzania to assess:

- **Ease of use**: did people treating their nets find it easy to use?
- **Acceptability**: are people willing to treat their nets at home themselves with insecticide?
- **Efficacy**: did people sleeping under their treated nets think that the treated nets were effective at killing and repelling mosquitoes? If so, how long did this effect last and what was the effect of washing the net?
- **Accuracy of target dose**: was the target dose obtained?
- **Preferred mode of delivery**: did people prefer using an insecticide presented to them in a tablet or a liquid form?

The study reinforced earlier findings that people in urban Dar es Salaam are able to treat their mosquito nets at home themselves and are very willing to do so. It also showed that the development of locally appropriate instructions needs careful consideration and that clearly labelling the insecticide as poison does not deter people from using it, it ensures that it is treated with respect, that the instructions are followed carefully and that it is stored out of reach of children. The study further confirmed that people who regularly sleep under a mosquito net notice a significant positive difference when that net is treated with insecticide. The study participants were happy with both modes of delivery of the insecticide (liquid and tablet forms) but there appeared to be a preference for the tablet. This in part was due to the extra strength of the tablet formulation, but if those who expressed a preference based on strength are removed from the analysis then among the 59 people who remain there is still a preference for the tablet based on its ease of use and safety of storage.

TITLE OF PROJECT: Vector bionomics in urban Surat.

COUNTRY: India

STAFF RESPONSIBLE: Roger Webber, Jo Lines, Pete Kolsky and David Bradley.

OVERSEAS COLLABORATORS: Dr R.S. Yadav, Dr R.M Bhatt, Dr V.P. Sharma Malaria Research Centre, Nadiad, Dr R.P. Sinha and Dr. V.R. Pathak, Surat Municipal Corporation, and Dr S.K. Mohanty MCRP, Surat

FUNDING: DFID - Indian Government

DURATION: 1998 - 2000

SUMMARY:

The Surat Municipal Corporation (SMC) has been carrying out larvicidal activity in the urban area in a non-targeted manner and mainly to control nuisance mosquitoes. The importance of different breeding sites for malaria vectors has not been determined, with many novel breeding places such as those created by the construction industry not evaluated. This project will work closely with SMC to establish an Entomology Monitoring Unit (EMU) to determine the breeding places of urban malaria vectors and their importance. It will also evaluate the susceptibility to the currently used insecticides and larvicides to rationalise their use in the programme and understand the mechanisms of insecticide resistance through enzyme kinetic studies. Engineering and environmental, as well as larvicidal approaches to control can then be formulated.

The first stage is to train existing SMC entomology staff in various entomology techniques, prior to larval sampling, indoor resting, light trap and human biting collections to determine vector bionomics. Species of mosquito will be identified and host blood meal determined by ELISA technique. Susceptibility to insecticides will be measured by WHO test kits.

TITLE OF PROJECT: Sensitivity of malarial parasites in urban Surat.

COUNTRY: India

STAFF RESPONSIBLE: Roger Webber, Jo Lines, Pete Kolsky and David Bradley.

OVERSEAS COLLABORATORS: Dr R.S. Yadav, Dr R.M Bhatt, Dr V.P. Sharma Malaria Research Centre, Nadiad, Dr R.P. Sinha and Dr. V.R. Pathak, Surat Municipal Corporation, and Dr S.K. Mohanty MCRP, Surat

FUNDING: DFID - Indian Government

DURATION: 1998 - 2000

SUMMARY:

Treatment of malaria in urban Surat is haphazard with often inadequate prescribing by unregistered practitioners. There is also an excessive presumptive treatment used in the urban area, amounting to a full course of therapy to persons presenting with fever. Chloroquine resistance has been reported so the sensitivity of both *P.falciparum* and *P.vivax* to anti-malaria drugs needs to be determined to allow rational treatment regimes to be formulated.

The first stage is to train existing SMC staff in various methods of resistance testing.

Standard 7 day *in vivo* evaluation of drug resistance and *in vitro* determination by WHO micro-test kits will be carried out among the local and migrant populations in at least 30 isolates.

TITLE OF PROJECT: A Kerosene lamp device for repelling mosquitoes.

COUNTRIES: Tanzania.

STAFF RESPONSIBLE: Helen Pates, Jo Lines, Caroline Jones.

OVERSEAS COLLABORATORS: Prof. Japhet Minjas, Muhimbili.

FUNDING: DFID

DURATION: 1997-98

SUMMARY:

The device uses a koroboi (the common home-made type of kerosene lamp found in many countries) to heat a volatile synthetic pyrethroid insecticide. The insecticide is dissolved at low concentration in a thin layer of vegetable oil, which is held in a tin supported by a tripod above the flame of the lamp. This allows maintenance of a stable 120-150 C, at which temperature the insecticide evaporates without being destroyed by the heat.

This device consistently gives about 90% reduction in biting rates (outperforming mosquito coils) at a cost (for materials alone) of about 1 US cent per night.